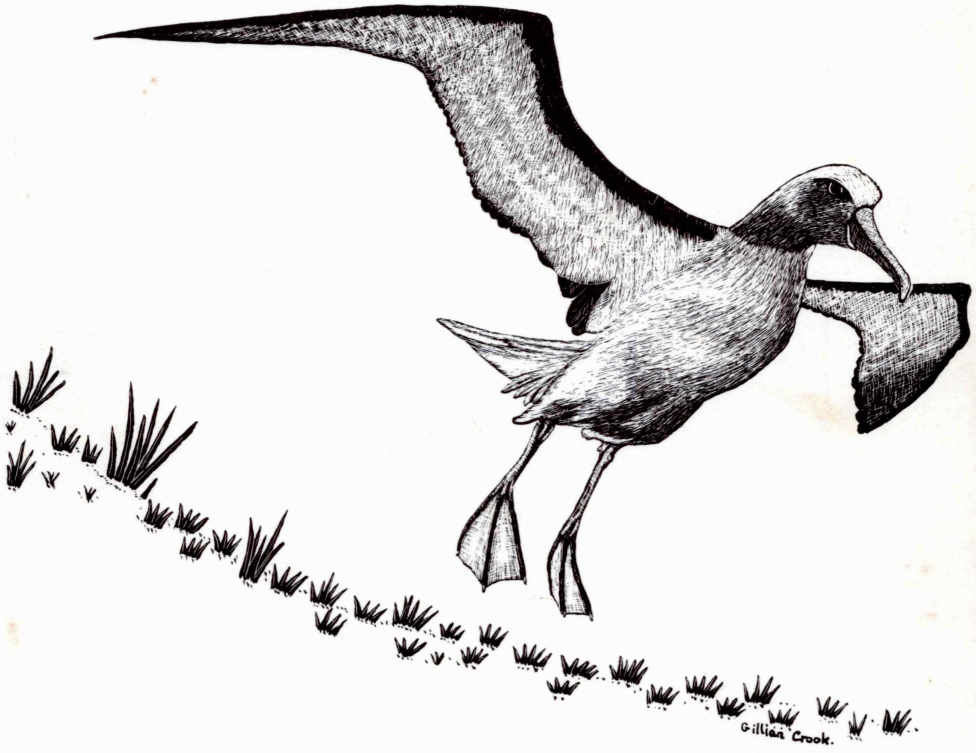
WILDLIFE
—A REVIEW



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WILDLIFE – A REVIEW

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FOREWORD

In August this year, what might be rather irreverently called the 16th Ornithological Olympiad was held in Canberra, the federal capital of Australia. For the first time in its history, the International Ornithological Congress - and its attendant International Congress for Bird Protection - convened in the Southern Hemisphere. In spite of many political, economic, domestic and personal difficulties, about 700 delegates arrived from all parts of the scientific world except Russia and China, and discussed advances in their branch of science and in conservation, giving special attention, as was fitting, to the avifaunas of Australasia, Oceania and the seas in which they lie. New Zealand was well represented at the Congresses and members of the Wildlife Service gave nine papers, showed films of their work and, after the formalities had ended so very successfully - thanks to the Australian hosts and organisers - entertained many of the overseas delegates in New Zealand by showing them at first hand some of our research and management problems which are very much island problems and all that that implies.

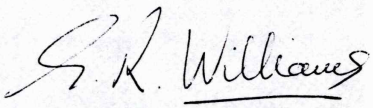
Around the three mainland islands there are some 700 others about 0.5 hectares in size or greater. Of these, over 600 lie within 50 kilometres of the mainland coasts and the remainder lie at distances as far as 800 kilometres away in an arc that stretches from the Kermadecs in the north-east, through the Chatham Islands to Campbell Island and the Auckland Islands in the far south. Of these 700 islands, approximately 100 are reserves of one kind or another, and make up a total area of some 100,000 hectares, of which the Auckland Islands comprise more than half.

The condition of the islands varies from being so heavily modified by man that they have virtually no biological interest, to being virtually in their original state, which makes them very valuable indeed - not only to New Zealand but to the whole world. For on some of the least modified and most isolated islands still occur rare animals and plants which have disappeared from all other parts of the world. On South-East Island in the Chatham group, for example, is a small population of the New Zealand shore plover, which was once common on various coasts of the mainland islands; and on Little Mangere Island, also in the Chatham group, is an even smaller population (less than 20 individuals) of the Chatham Island robin, which must be one of the rarest species in the world not in immediate danger of extinction. There are other examples of this kind in the New Zealand region.

Adams Island - the second largest island in the Auckland

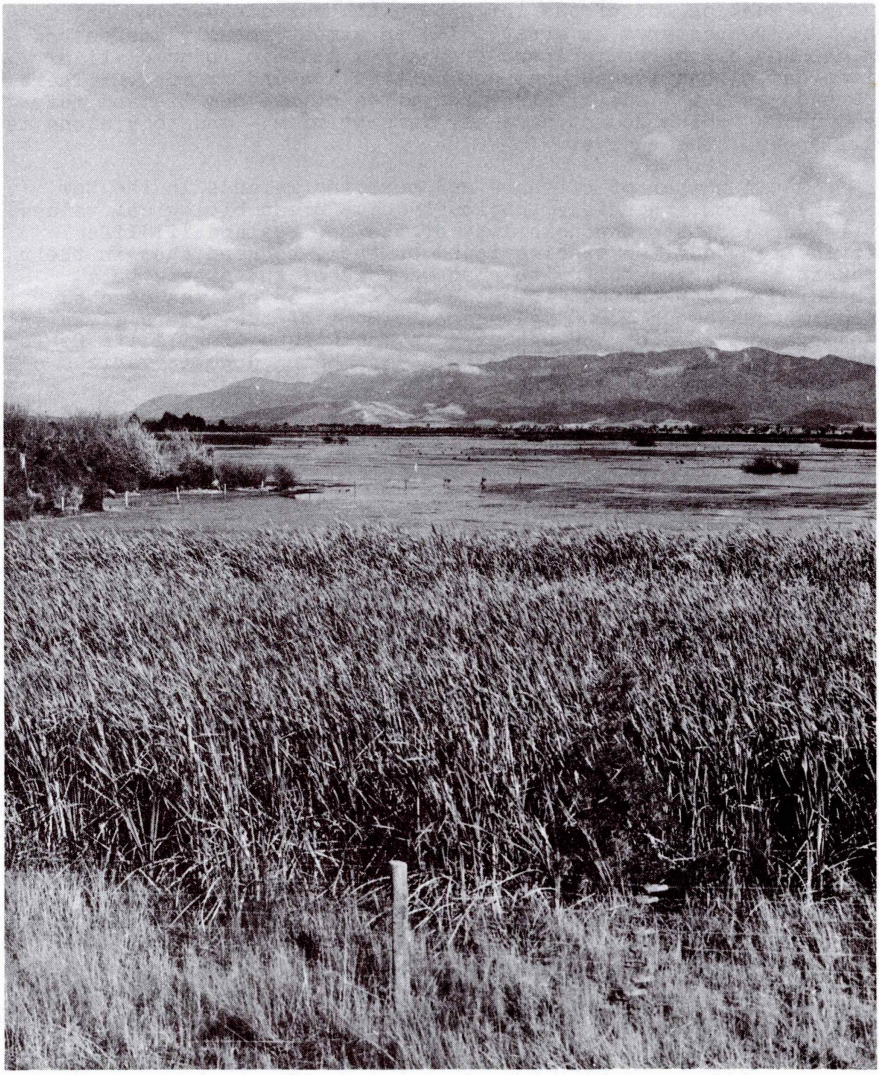
group - must be one of the largest in the world (even though it is only 10,100 hectares in area) which is almost totally unaffected by man and his works. Apart from a few self-introduced alien birds and plants its natural communities are undisturbed. There are even some islands within a few miles of the New Zealand mainland coasts which do not have any rats or mice - and this alone is rare enough, these days.

A number of offshore and outlying islands in the New Zealand region, therefore, obviously have great biological values. It is part of the responsibility of the New Zealand Wildlife Service to study the species found on them, to keep them in their present state, and to try to restore some of the others to a condition closer to that in which they were before man reached these shores about 1,000 years ago. Some of the papers given in Canberra and some of the articles in this issue of Wildlife Review give an account of the work of this kind being done in various odd corners of the New Zealand archipelago.



Head

New Zealand Wildlife Service



Boggy Pond Wildlife Management Reserve. A valuable wetland that has been excluded from the Lower Wairarapa Development Scheme. Photo: J.L. Kendrick.

WETLAND CONSERVATION

G. P. Adams

senior game management officer

Wetlands are a natural resource comparable in value to forests and farmland. The definition of wetland in New Zealand is similar to that published by the IUCN in its Bulletin Vol. 4 No.4 April 1973. This bulletin summarises the major functions of wetlands thus: water regime regulation, flood control, erosion control, nursery areas for food fishes and crustacea, fish production, waterfowl production and maintenance, recreational uses, educational uses, plant production, scientific research, aesthetic enjoyment, wildlife habitat, landscape.

Many of the wetland losses have, in the past, been necessary for the establishment of a sound economy and the Wildlife Service is realistic enough to understand and accept this situation. What it is not prepared to accept is the unrestricted and perhaps total drainage of wetlands, and the loss to the people of New Zealand of their many values.

New Zealand is a country which in the past has been almost totally dependent for its export earnings on its ability to produce a variety of cheap agricultural products. This dependence on agriculture has led to the transformation of much of the country's natural environment into farmland. As the demand for pasture has increased, so the land developers have moved into once less desirable land types which include wetlands; and, while drainage of wetlands has always been with us since the early days of colonisation, it has steadily increased as land available for development has diminished. It is unlikely that this pressure will ever completely ease. Human population increases and the need to maintain our way of life will require increased production in a country with a relatively small land area (265,143 square kilometres).

Between the late 1890s and early 1960s losses of wetlands had reached such proportions that if projected drainage schemes had been implemented virtually no wetlands of any consequence would have remained in any of the important wildlife areas. This would have resulted in at least local and possibly national extinction of some water-bird species, and the recreation associated with wetlands and wildlife would have been severely curtailed.

Balham (1953), in discussing factors contributing to the reduction of waterfowl and habitats in the Manawatu, makes mention of once vast swamps (24,000 hectares) of which only remnants remained in 1952. Nevertheless, drainage has continued.

In 1964 the Wildlife Service made a survey of the extent of wetlands drainage throughout the country over the preceding 10 years and found that about 160,000 hectares had been lost. Also in that year, the Department submitted to the Nature Conservation Council a paper on the conservation of wetlands. This paper, in referring to the remnants summarised the values of wetlands and made recommendations which, if implemented, would lead to (1) co-ordination of the activities of development agencies, and (2) to a programme to conserve wetlands.

While these proposals were accepted in principle, nothing definite resulted. It is probable that the era of environmental concern had not then arrived and too few people were interested in the problem. Many of the land developing agencies continued with their activities and ignored efforts to save even some wetlands.

Not all was lost, however, as the Wildlife Service embarked upon a campaign to bring to the notice of these agencies and to the public the threat to the continued existence of the nation's wetlands. Gradually, the need for some wetlands to be preserved was accepted by some influential organisations; and this recognition was particularly notable in the Waikato and Hauraki regions where significant areas of wetland remained. These lie adjacent to New Zealand's largest population centre and provide a major recreational outlet.

Agreement was reached in 1968 with the Department of Lands and Survey, Ministry of Works, and advisory boards set up under the auspices of the Ministry, as to which wetlands in the Waikato and Hauraki regions would be reserved for wildlife and ecological purposes. However, not all local authorities concurred, and today, none of those wetlands has yet been reserved. A similar situation exists in other parts of New Zealand.

In 1968, on the initiative of the Department of Internal Affairs, the Minister of Lands announced that important wetlands on his Department's land settlement blocks would be set aside as public reserves and vested for control and management with the Minister of Internal Affairs. The Wildlife Service was to reimburse the Department of Lands and Survey for the cost of the land. It was not until the 1973 financial year that approval was finally given for reimbursement to be made, and in that year 11 wetlands totalling 980 hectares were paid for.

At the same time other suitable Crown-owned wetlands were being set aside for wildlife purposes; but here again progress has been extremely slow with, to date, only 11 such areas having been reserved, although many others, such as those in the Waikato and Hauraki, are still under consideration.

Several acclimatisation societies responded to the call for wetland conservation and have made purchases of some important areas.

Although losses of wetlands were known up to 1964, continuing losses have not been documented. In the hope of encouraging more positive action towards conservation, an inter-departmental conference was called at the initiative of the Department of Internal Affairs in 1969, at which the Department undertook to make an evaluation of all wetlands in New Zealand. While the results of

such an evaluation were to be available for all users, its primary purpose was to identify those wetlands which should be preserved, either as wildlife, botanical, or water conservation areas etc. Progress has so far been slow because of manpower shortages in the Wildlife Service.

The Land Resources and Land Use report to the Physical Environment Conference in 1970 drew attention to the fact that the conversion of wetland areas to agriculturally productive land had gone so far that only remnants of natural wetlands were left. The report contained recommendations for wetland conservation. The Environmental Council in its report on the preservation of wetlands (December 1973) recommended to the Minister for the Environment that a fund be established to be used for the purchase of wetlands. Representations are at present being made by the Wildlife Service for the establishment of such a fund. The Council also recommended that Government make a statement of policy declaring wetlands to be a scarce national resource.

Perhaps the most significant event was Government's requirement that from March 1974 an environmental impact assessment would be obligatory for all Government financed, approved or licenced operations. This requirement includes most agencies and activities which affect wetlands.

In summary, it would at first glance appear that little has been achieved in conserving wetlands; indeed, many wetlands have been lost since the Wildlife Service first took an interest. While very few wetlands have been set aside as reserves, however, two important things have occurred:

1. The public, Government Departments and local authorities are now more aware of the need for conservation, and requirements such as the environmental impact assessments will force land development agencies to give consideration to other values.

2. Many wetlands that would have long since been drained are at least still in existence today, even though they are not reserved.

There is still cause for concern and efforts cannot be relaxed, as evidenced by drainage proposals of both central and local government agencies.

* * *

THE MALLARD/GREY SITUATION

T. A. Caithness
scientist

Mallards, from the British Isles, were first introduced into New Zealand about one hundred years ago, but although they became established in some areas, they never thrived. Then, in the mid 1930s, more birds were imported, this time from the U.S.A. A vigorous programme of game-farm breeding and later release into the wild was adopted by several acclimatisation societies and continued in some districts through to the early 1960s. As a result of this, mallards now range throughout the country and dominate the waterfowl scene.

Of the two major game duck species - grey and mallard - shot in 1973, 64 out of every 100 were mallards.

Some hunters, and most ornithologists and conservationists have long deplored the decline of the native grey duck and allege that competition from the more aggressive mallard is the cause. Further, cross breeding between the species is said by some to be serious. In 1956 an analysis of band returns showed that grey duck mortality rates were far higher than those for mallards. These mortality rates showed that every pair of grey duck, with an average clutch size of ten eggs, would need to rear about four and a half young to the flying stage to maintain a stable population. Mallards with an average clutch size of thirteen eggs only needed to rear a little less than three birds per pair. On top of all this grey ducks decoy readily and are consequently more vulnerable to hunting than the wary mallard.

In the light of the obvious problems grey duck have had to face, what then is the present situation?

They are still shot harder than mallards but a recent analysis of band returns shows that grey ducks are now surviving better and have only to produce a little more than three birds per pair to the flying stage to maintain a stable population.

Mallards are doing even better; they only need to rear about two birds per pair and both species are quite capable of producing the number of young required.

It seems then, that the grey duck population should now be at least stable, whereas the mallard population is surely still increasing.

I contend that the size and stability of the grey duck population is directly related to the amount and stability of the

"wild" wetlands on which they depend. Mallards on the other hand are most numerous in those land districts where development has been greatest. It is rare indeed to ever see grey ducks on city ponds or streams, or on rivers, lakes, lagoons, and farm ponds where disturbance by humans is frequent. Mallards are common in such places; their whole history throughout their native range parallels this, as mallards readily accept a domestic situation. In fact, of all the various species of dabbling duck, only the mallard has been domesticated; and all domestic ducks khaki campbell, Indian runner, Pekin etc., are, therefore, merely line-bred mallards. It is this domestic tendency which is the secret of their success. It does not mean, however, that mallards will not frequent "wild" regions, because they indeed do; but I think that in such places grey duck, having evolved in these conditions, are not disadvantaged.

Table 1 clearly shows that mallards form a very much lesser part of the hunters' bag in the South Island districts where rural development and urbanisation is minimal, i.e., the Westland and West Coast Acclimatisation Districts. As development intensifies, mallards become more important, i.e. in the Nelson, Marlborough and Southern Lakes districts. While, in the highly developed South Island east coast districts, and in Southland especially, mallards very much dominate the bag.

At this stage of my analysis, I have merely compared the ratios of grey and mallard in each acclimatisation society district, the boundaries of which are both geographical and administrative. If the analysis was done in a different manner i.e. if all the data from South Island back country lakes and rivers were separated from the data collected in intensively-farmed and settled lowland areas, then the differences would certainly be even more obvious.

Table 1. Proportions of mallard and grey duck in the hunters' bag in South Island Acclimatisation Society districts (Average of six seasons 1968 to 1973).

	% Mallard	% Grey
West Coast	18	82
Westland	19	81
Nelson	40	60
Marlborough	45	55
Southern Lakes	54	46
South Canterbury	70	30
North Canterbury	71	29
Waitaki Valley	74	26
Otago	82	18
Ashburton	83	17
Southland	89	11

Table 2 shows that a similar pattern occurs in the North Island. In regions like Hawkes Bay, Wellington East (Wairarapa), Wellington West (Manawatu) etc., where land development must be as close to the maximum as it could ever be, mallards are overwhelmingly dominant whereas in Northland, where large tracts of wild swampland still remain, the grey duck is dominant. Land development programmes currently under way in Northland will undoubtably influence the grey - mallard ratios to the detriment of the grey duck.

Table 2. Proportions of mallard and grey duck in the hunters' bag in North Island Acclimatisation Society districts (Average of six seasons 1968 to 1973).

	% Mallard	% Grey
Northland	25	75
Central Rotorua	30	70
Taupo	32	68
Taranaki	35	65
Stratford	39	61
Bay of Plenty	45	55
Waimarino	46	54
Tauranga	47	53
Gisborne East Coast	49	51
Auckland	55	45
Hawera	63	37
Wanganui	72	28
Wellington West	74	26
Wellington East	79	21
Hawkes Bay	81	19

I do not consider that cross-breeding is the problem that it is often alleged to be. Hybridization certainly occurs but it is probably confined to those areas where greys are persisting in low numbers on what is, for them, marginal habitat. On Pukepuke Lagoon in the Manawatu district, waterfowl are constantly observed throughout the breeding season. Of hundreds of pairs of birds, mainly mallards with about 20% greys, not once has mating between the species been reported, and this after seven years of observations.

Mallards, it seems, have merely filled the ecological niche left vacant by grey ducks in a developing countryside, a countryside which without mallards would very likely be devoid of wild duck.

Providing sufficient wild wetlands, the prime requisite of grey duck, are retained, this game bird should sustain its numbers.

CONSERVATION OF BROWN TEAL

M. J. Williams
scientist

The brown teal, an endemic species, is almost certainly New Zealand's rarest duck. From being widespread over much of the country at the turn of the century, it is now restricted to parts of Fiordland and Stewart Island in the south and to parts of Northland and Great Barrier Island in the north.

Although no definite assessment of total population has been made, evidence of an increasingly restricted distribution causes some concern.

Within New Zealand, the species has been successfully kept and bred in captivity by private aviculturalists, zoos and the Wildlife Service. It has also bred in captivity overseas. Like other dabbling ducks it adapts readily to captivity and, apart from its quarrelsome nature, presents no special avicultural problems. In the wild, the bird favours small swampy streams and tidal creeks and is largely crepuscular in habit, feeding on pasture and sheltered portions of coast. In captivity it readily accepts being placed with other species on artificial ponds, adopting a diurnal pattern of activity and feeding on the typical diet provided for captive ducks of grain, poultry pellets and bread etc.

M.J. Williams and W.J. Pengelly releasing brown teal at Lake Koputara in the Manawatu.
Photo: T.A. Caithness.

To date, breeders have not attempted a full-scale rearing programme but have merely replaced their losses and maintained suitable numbers on the ponds. The small surpluses that have been reared have formed the basis of trial liberations. They have been released at two localities in Northland but the success of this has not been satisfactorily established because the liberations were within the species' current natural range. A liberation of ten birds onto Kapiti Island in 1968, however, proved highly successful. Within four months of release, at least one female had bred and in the subsequent three breeding seasons at least 70 ducklings are known to have fledged. Surplus stock, including pinioned birds from the Mount Bruce Native Bird Reserve, were released in the Manawatu in 1973 and although breeding has not been established, some birds were known to be surviving at the end of the year.

Encouraged by these results, the Wildlife Service has

begun a major captive-rearing programme in an effort to re-establish the species in parts of its former range. The project involves eight private aviculturalists and the Wildlife Service's facilities at the Mt Bruce Native Bird Reserve and the aim is to rear 200 birds for liberation each year. Releases will initially be made in the Manawatu district - an area where the bird was last recorded in the 1930s and where at least some of its original habitat still remains. Depending on the success of this liberation it is envisaged that releases of both captive-reared and wild-caught birds will later be made in parts of Taranaki, Nelson and West Coast.

PARADISE SHELDUCK

M. J. Williams

For a while after man first colonised New Zealand, the paradise shelduck, the largest and most conspicuous of our native waterfowl, was intensively exploited for food. The Maoris were quick to appreciate that the species was flightless during the moult and the ornithologist W.L. Buller reported that they rounded up over 5,000 birds in a single operation in Marlborough last century. Although local exploitation on that scale no longer occurs, the species is a popular game-bird and approximately 20,000 are shot throughout the country during the annual game season. The tendency in the past has been to regard the paradise shelduck as a "duck" and attempt to harvest it at the same level as grey duck and mallard. As a result, the species has, in the 108 years of controlled shooting, been taken off the game licence many times to allow local populations to recover. However, as our knowledge of the species improved, so the necessity for a more rational exploitation became apparent and today it is only lightly harvested.

Research on paradise shelduck started in 1961. Birds in two districts - Gisborne and Taihape - were banded to determine mortality rates and dispersion. This study ceased in 1969 after 6,800 moulting birds had been banded. The results showed the species to be particularly sedentary. Approximately 95% of the recoveries were within a 75 km radius of the banding site and more than half of the recoveries were within a 30 km radius. Although the Gisborne and Taihape banding sites were only 140 km apart, there was no evidence of movement between the populations. Mortality rates, while being of a similar magnitude in the two areas, were nevertheless sufficiently different to preclude, at least initially, the possibility of monitoring the species on a national scale from the study of a single population. Banding of moulting birds therefore continues at Gisborne and Taihape in the North Island and was recently started at Lake Luxmore, Omarama,

Lake Matiri and Molesworth in the South Island. Five hundred birds will be banded annually at each site for a period of five years. The results will then be compared with Gisborne, the permanent banding station, to ascertain whether this area only may be used to monitor the species on a national scale.

Because birds banded on moulting sites were all one year old or older, we have no knowledge of mortality rates and dispersion of birds during their first year of life. Therefore, ducklings are now being banded at two localities. Officers of the Southland Acclimatisation Society band 500 ducklings each year in their district, while at Gisborne, 200 are banded annually. This programme will continue for five years in each district.

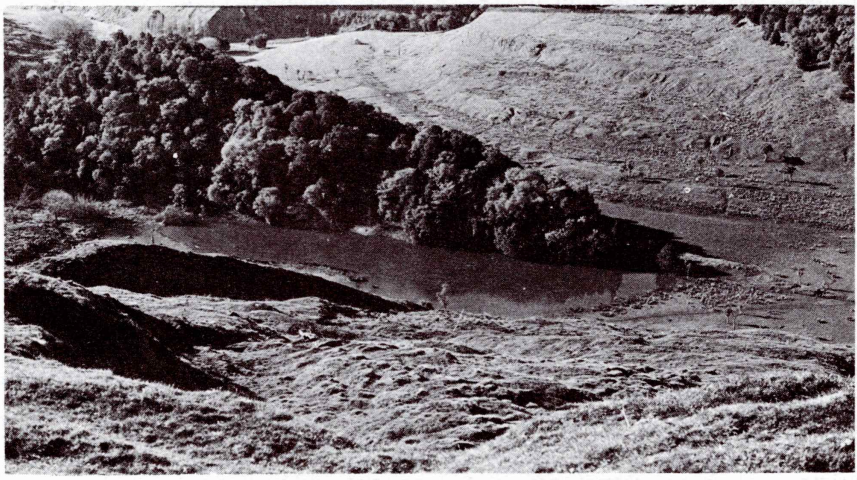
Knowing mortality rates is not in itself sufficient. To determine the optimum level of exploitation it is necessary to know the average annual productivity of each breeding pair. This type of information is usually collected by Wildlife district field officers but their other duties preclude them from observing specific pairs frequently.

How important is frequent observation? For the first two years the Gisborne officer followed a limited number of pairs on the basis of one observation every two-three weeks and last year the frequency was increased to once a week. To determine the reliability of this data I followed a number of pairs on a day to day basis throughout the breeding season. This work started in 1973 and will continue until 1975. The study area, on Huiarua Station north of Gisborne, covers 4,800 ha of steep hill country ranging in elevation from 450 - 1200 m. It is papa country (a mudstone of upper Tertiary origin) which, while excellent for pasture, is very prone to slipping and slumping. Scattered throughout the area are about 50 ponds - mostly man-made stock drinking ponds but some are created by slips. Also included in the study area is a 7.5 km length of the Mata River.

In determining the production per breeding pair at fledging a number of separate investigations are involved. Firstly, precisely which are the breeding pairs? The population comprises a large "flock" plus a number of separate pairs. Do both of these components attempt breeding? On an a priori basis it is likely that only "territorial" pairs, i.e., those spaced apart from the flock, will attempt breeding. But previous work by the Gisborne Wildlife officers showed that some of these pairs made no apparent breeding attempt. Would more intensive observation reveal the same? Secondly, having identified the breeding pairs, it is necessary to determine the percentage that successfully hatch their eggs. If renesting occurs, this must also be followed. Finally, broods must be followed daily to record those which do not survive, as well as the number which fledge from successful broods.

The flock during the 1973 breeding season (July-November) contained up to 70 birds which, for the most part, confined their activities to three areas of good feeding. One such area was adjacent to a large water empoundment formed by a major slip. An extensive area of pasture had become a semi-swamp and produced

highly-favoured food for the birds. The flock appeared to be comprised almost exclusively of birds in their first year of life. Although ducklings have been banded in the area for the previous three years, the only banded birds observed in the flock were ducklings of the previous summer. However, it is too soon to be adamant that adults, i.e., those 2 years and older, do not form part of the flock.

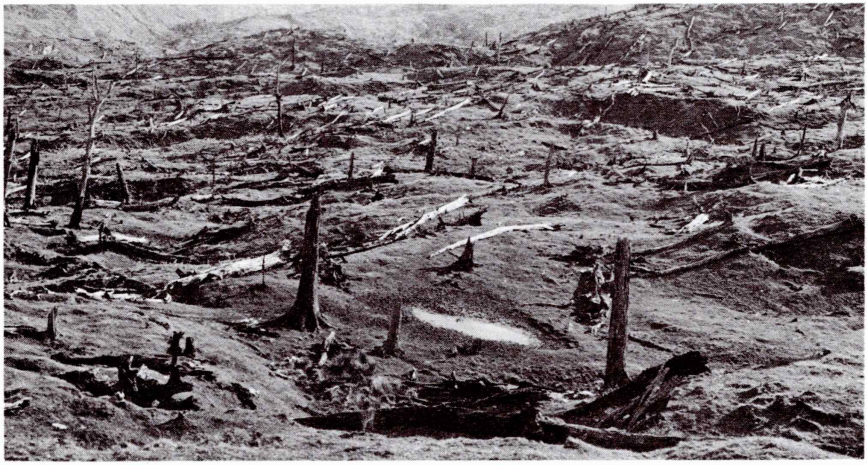


The main paradise shelduck flock area on Huiarua Station. Photo: M.J. Williams.

The breeding component of the population appears at this stage to be the separate pairs. Each pair occupies an area of many hectares which usually includes at least one water impoundment (or portion of river) and a number of swampy areas for feeding. Each pair confines itself to this area and defends it against other paradise duck so that they may be considered territorial in the classical sense.

In 1973, the first year of the intensive study, 25 pairs were observed at least once each day during the period from late July until mid-November. The initial decision on whether a particular pair attempted to breed was based on their behaviour. I did not observe the members of a pair separate from each other at this time of year except when the female was at the nest. Thus,a sighting of the male alone on the territory is probably indicative of the female being at the nest. However, immediately prior to egg-laying,females appeared very gravid,i.e., the lower abdomen became greatly distended - a feature shown in other waterfowl species to coincide with egg development. Thus, the observation of a gravid female and the subsequent sighting of her male alone on the territory were together taken as an indication of a breeding attempt. In most cases this was confirmed by the female's pattern of attendance at the territory. During egg-laying she was usually absent from the territory for one to three hours each day and during incubation she was present for about one hour three or four times each day.

Of the 25 pairs studied, 12 (48%) appeared with ducklings, 9 (36%) attempted to breed but failed and 4 (16%) apparently did not attempt to breed. The probability of detecting a breeding attempt which may fail during egg-laying is very low, particularly when the frequency of observation is only once (and perhaps of only five minutes duration) each day. The male of one breeding pair accompanied his female to the nest-site and waited for her there while she laid her first egg. If this behaviour is typical of other pairs, the chance of detecting early failure is further reduced. Thus, the best that can at present be said is that the successful breeding pairs - those that appeared with ducklings - represent between 48-57% of the pairs which attempted to breed.



Paradise shelduck habitat on Huiarua Station. The remains of the original forest cover provide an abundance of nest sites. Photo: M.J. Williams.

Like other species of shelduck, the age at first breeding is two years. Of particular interest this season was one pair, the female of which was unbanded and therefore of unknown age but the male was banded as a duckling the previous summer. The female appeared very gravid and shortly after disappeared from the territory for two to three hours on each of four consecutive days, the male remaining on the territory. Thereafter, however, the pair was always seen together on the territory. This pair was considered to have attempted breeding but to have failed very early. The one-year old male was shot 14 days after the female had last left the territory and his testes examined microscopically. Although spermatids and spermatocytes were present, no spermatozoa were detected. This male may have been sexually active in the behavioural sense and may even have copulated with his mate but it is most unlikely that he fertilised her eggs.

The study area contains a super-abundance of nest sites. Hollow logs are highly favoured and the remains of the original forest cover, felled in the 1930 s, lie scattered over the hillsides. Burrows left after tree roots have decayed are also favoured nest sites and holes in trees are sometimes used. Not all nests are located close to the feeding territories - one nest found last year was about 3 km from the territory pond. One incident of nest parasitism was detected, a common activity in at least one other species of shelduck. One female, after laying an unknown number of eggs, commenced incubation about 5 September. During the last 10 days of incubation another female laid at least two eggs in the nest.

The survival of ducklings was followed by observing 20 broods each day throughout their development. No ducklings fledged from five of these broods and from the remainder an average of 5.5 ducklings fledged. Since successful brood pairs represent 75% of those which first appeared with ducklings and they in turn were 48-57% of the breeding pairs, the production per breeding pair was 2.0-2.4 ducklings to fledging.

Such results are, of course, only preliminary ones but combined with those from the next two years of the study they should provide a sounder basis for the management of this game species. After 1975, research on paradise shelduck will continue but it will be more of a monitoring programme than research in detail.

LEAD POISONING IN WATERFOWL

T. A. Caithness

Waterfowl have occasionally been recorded as dying from lead-poisoning following the ingestion of lead shot taken in mistake for grit.

In 1956 the first and only review of lead poisoning in New Zealand waterfowl, by B. Wisely and K.H. Miers, was published. Since then, the problem was largely ignored until the Pukepuke Research Project began in 1968. At Pukepuke Lagoon and other dune lakes nearby the constant observation of waterfowl behaviour and productivity, coupled with the intensive game season hunting that occurs, enables us to monitor the occurrences of lead-poisoning.

Since May 1969, 122 waterfowl, either moribund, freshly dead or as skeletons, have been found. Seven were from Omanuka Lagoon, three from Lake Kaikokopu, two from Foxton No.3 and the

remainder from Pukepuke Lagoon. The following table sets out the broad statistics of those which had shot in the gizzard. (The total number that may have died from lead poisoning could not be estimated as many skeletons were so disturbed that it was impossible to detect whether lead shot had or had not been present.

	No. of Birds	Male	Female	Average No. Shot	Range
MALLARD					
1969-1970	18	15	?	35	1-176
1970-1971	0	-	-	-	-
1971-1972	7	7	0	16	1- 47
1972-1973	18	17	1	42	1-284
1973-1974	7	7	0	38	1- 81
Totals	50	46	1	35	1-284
GREY					
1969-1970	1	?	?	1	1
1972-1973	2	1	1	105	45-164
Totals	3	1	1	70	1-164
BLACK SWAN					
1969-1970	4	?	?	68	1-214
1970-1971	1	?	?	15	15
1971-1972	2	?	1	7	6- 8
1972-1973	1	?	?	15	15
Totals	8	?	1	40	1-214

From this information, the following inferences can be made.

1. As 98% of the mallards carrying shot were males there is an implication that males differ from females in feeding habits or certainly differ in grit requirements during falling water levels in summer months. A similar pattern has been recorded overseas.

2. Water level is a critical factor. In 1970/71, a year of stable water levels, no dabbling duck mortality from lead poisoning was detected. At Pukepuke Lagoon, with its maximum depth of about one metre, lead poisoning has not occurred to any marked extent until the water level has dropped about 30 cm below normal.

3. As 85% of the mortality occurred in adults it seems that juveniles in the first few months of life do not require grit to the same extent as adults during the same period. This is also a pattern that has been recorded overseas.

4. As shoveler have not been affected it seems that, because of their high preference for freshwater invertebrates and total

disinterest in pasture and crop-grain feeding, they do not require grit in the form of stones etc. Snail shells and hard seeds probably suffice.

5. In the Pukepuke region it seems that lead poisoning could be a significant mortality factor among swans. The incidence of lead poisoning appears to be high in relation to the low population.

Lead poisoning associated with shallow water areas that are subject to hunting and fluctuating water levels can be severe. The question is, what to do about it?

At Pukepuke Lagoon over the past two seasons, we set out ten shot traps (one metre square trays) along two transects that would sample to the 30 cm draw-down level on prime feeding areas.

Only one third and one quarter of the "normal" duck harvest were shot in the 1973 and 1974 game seasons respectively - both drought years. The shot traps revealed that 50,000 and 23,000 shot per hectare were deposited in each year on the critical feeding area.

There is only an academic value in assessing annual shot deposit rates on a given water area. We could, however, establish that only new season shot persists in the upper substrate and remains available for ingestion the following summer. It is likely that the yielding surface texture of most wetlands and wave action ensure that shot gravitates to below the normal reach of ducks fairly rapidly.

Now we propose to set out ten trays, each four metres square and containing a given amount of sized grit. The site of each tray will be suitably marked so that a visual check can be made of birds feeding over them. At the end of the summer or just prior to the 1975 game season, the trays will be lifted and an estimate made of the grit taken.

Should birds take any appreciable amount of the grit a reduction in the amount of shot taken can be expected and this will show up in the numbers of dead waterfowl that are found. As an absence of lead poisoning could be due solely to a lack of any significant fall in water levels the experiment will be repeated in successive seasons until water level fluctuations have been such that we can evaluate the experiment conclusively. In the event of a significant reduction in expected lead poisoning during the course of these trials, we can, with a degree of optimism, expand the technique of supplying grit to other wetlands subject to hunting and summer draw-down.

North American literature and statistics on lead poisoning in waterfowl are often quoted in this context. I do not consider it valid, however, to equate the North American situation with that in New Zealand.

North America experiences a continental climate which is characterised by summer and winter extremes. Consequently, there are large tracts of semi-permanent waters and much marshland which virtually disappear seasonally. Such places, if hunted over, could be death traps for waterfowl.

In New Zealand we enjoy a temperate climate and have marked reductions in water levels of most wetlands only in drought years.

Another important point is that many of our waterfowl hunting grounds have deep water or are sufficiently deep to preclude dabbling ducks and swan from reaching whatever lead shot is on the bottom. Further, even where margins are shallow and where hunters build shore based hides shot is invariably discharged over the decoys and into deeper water. It is completely idle for us, or the North Americans for that matter, to speculate on how much lead shot is distributed over wetlands annually and from this to make computations on what the likely lead poisoning mortality will be. By far the majority of lead shot falls in "safe" places.

There are regular reports on the progress being made on the research and development of acceptable lead shot substitutes. This line of enquiry has been bedevilled by the desire to have the substitute shot perform in a ballistically similar way to lead. Progress has been made, however. Soft iron No.4 pellets will perform similarly to No.4 lead shot if a higher charge is used. However, most duck hunters prefer to use No.6 shot and at ranges above forty metres this preference is justified as No.6 lead shot outperforms No.4 lead shot and No.4 iron shot in particular. This information is reported by Andrews and Longcare in their paper on "The Killing Efficiency of Soft Iron Shot" presented to the Thirty-fourth North American Wildlife and Natural Resources Conference 1969. The authors also noted that crippling losses were not likely to be any higher by using soft iron shot with similar ballistics as their trial ammunition.

Several serious problems remain with the development and use of lead shot substitutes: (1) Many shotguns currently in use simply could not withstand the higher charge necessary for comparable killing efficiency with lead shot ammunition. (2) Most, if not all, guns used in the development of soft iron shot have suffered either severe barrel wear or choke deformation or both. (3) Production costs are higher, one source quotes iron shot at $1.00 U.S. per packet more than lead shot equivalents.

If and when the substitutes are available, the three problems relating to lead shot substitutes outlined above will undoubtedly result in substantial consumer resistance.

One important point generally overlooked by hunters and game managers when debating the pros and cons of lead shot is that heavy metals such as lead and mercury, when unnaturally released, can be evironmentally harmful. What then of the very large aggregations of lead in some of the heavily hunted wetlands? I estimate that at Pukepuke Lagoon lead pellets could be present at the rate of about eight million per hectare, the accumulation of one hundred years of hunting. Eels, principally short-finned, abound in Pukepuke Lagoon and are the major carnivores in the ecosystem. We now propose to expand the research effort into the possible accumulation of lead in eels and the sediments in which they live and sometimes forage. Shags will also be similarly sampled as they feed heavily on eels in this region.

Further research is essential on all aspects of the lead shot dilemma in New Zealand and is proceeding as rapidly as resources will permit.

ALBATROSSES OF THE CHATHAM ISLANDS

C. J. R. Robertson
technical officer

During the summer of 1973/74 a research team spent three months in the Chatham Islands studying the populations of the northern royal albatross, Buller's mollymawk and Chatham Island mollymawk. All islands were visted during the expedition and a total of 64 days was spent in detailed studies on the Middle Sister.

THE PYRAMID

This southernmost island of the Chathams group is a steep volcanic plug reaching a height of 172 metres and is the only breeding ground of the Chatham Island mollymawk. Various previous estimates of the population range from a few hundred by Beck in March 1926 to 2,000 pairs estimated by Dawson from sea-based photographs in October 1964. A count taken from R.N.Z.A.F. vertical photographs of December 1972 revealed an estimated population of 4,000 pairs plus or minus 5%. A further air survey showed some 50-60% of nest sites occupied in early August 1973, which suggests a rather earlier onset of the breeding season than that previously postulated by Dawson. Our visit on 21 February 1974 covered all parts of the island not previously surveyed. There was an indication of low survival, with only some 30% of nests containing partly feathered chicks, though most remaining nest sites were occupied by adults. It was evident during the climb to the summit that many ledges on which breeding occurs were invisible from sea level, and this would account for the relatively low estimate made by Dawson in 1964. One bird of the closely-related sub-species, Salvin's mollymawk, which breeds at the Bounty Islands and The Snares, was found on the island.

THE FORTY-FOURS

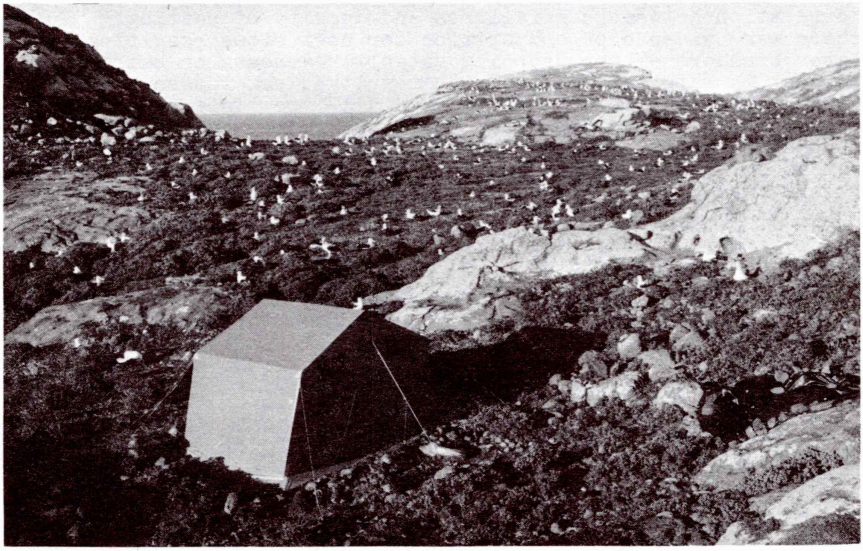
A group consisting of one large island and a number of stacks, the Forty-Fours form the eastern outliers of the Chathams group. Analysis by the Geological Survey, D.S.I.R., of rock samples collected by us, revealed the basic composition as grey-wacke, making these islands the most easterly recorded site of New Zealand mainland rocks.

With a maximum height of 100 metres the main island of some 14 hectares is basically flat-topped and bounded by sheer cliffs. The top is densely covered with the nests of three large sea birds - the northern royal albatross, Buller's mollymawk, and the northern giant petrel. Analysis of R.N.Z.A.F. photographs shows that the northern royal albatross occupies some 6.4 hectares at a density up to 520/hectare per breeding season.

The total breeding population on the island of this biennially breeding species is probably 5,000 pairs.

An estimated population of 1,000 to 1,500 pairs of northern giant petrels utilises the same areas of the island as the northern royal albatross.

The Buller's mollymawk uses some 5.3 hectares of the remainder of the island in areas almost entirely devoid of vegetation. The birds are almost completely colonial breeders with few nesting on cliffs. This may explain the slightly earlier season indicated by the size of the chicks seen. Based on probable density of one nest per square metre over 45% of the utilised area an estimated population of 23-24,000 pairs is indicated.



Expedition camp and nesting royal albatrosses on Middle Sister Island. Photo: A. Wright.

THE SISTERS

This group of two islands and a low-lying reef form the northern outliers of the Chatham group. Basically volcanic with an eroded cap of sedimentary rocks the two main islands range from 40 to 90 metres in height and are occupied by the same large sea bird species as the Forty-Fours. While only one brief visit was made to the Big Sister, two thirty-two day visits were made in October/November and January/February to the Middle Sister. Studies were made of the breeding biology of the northern royal albatross and Buller's mollymawk.

(a) Northern Royal Albatross

The Big Sister supports an estimated total breeding population of 1,560 pairs, but the Middle Sister has an estimated total of 1,150 pairs. Whereas the birds are spread relatively evenly on the Big Sister and the Forty-Fours, only a small part of the Middle Sister appeared to have suitable habitat and on some parts nesting density approached 800/hectare. All of these densities are significant when compared with an estimated density of 20/hectare in the southern royal albatross population at Campbell Island and a maximum of some 120/hectare in a dense part of the wandering albatross population at South Georgia as reported by Tickell.

Compared with other royal albatross populations away from the Chathams, there was a significant increase in aggressive behaviour; and preliminary analysis of data suggests a correlation between egg failures and density of nesting. Further, there was evidence of competition for nest sites resulting in later breeders either usurping established nests or being forced to nest in marginal habitat with resultant egg losses. Comparison with breeding data since 1937 from Taiaroa Head on Otago Peninsula, confirms the similar breeding cycles of the two populations; and the recovery on the Middle Sister of a bird banded as a non-breeding transient at Taiaroa Head supports the theory that that colony is an overflow from the main Chatham populations.

(b) Buller's Mollymawk

Unlike the large colonial population of the Buller's mollymawk at the Forty-Fours, those at the Sisters are predominantly cliff-nesters with groups of nests rarely exceeding 20. The total population is estimated at 2,000 pairs with 500 on the Middle Sister.

Though egg-laying extended from 26 October to 23 November, 96% of eggs were laid in a 12 day period 4/16 November. This is in marked contrast to the later (January/March) and longer laying period of the species at the Snares. The incubation period is 69 days.

"BIRDING"

Investigations into the history of birding revealed that the taking of birds by Chatham Islanders was irregular from early this century until the 1940 s and, apart from some depredations by cray fishermen during the 1960 s, virtually non-existent since then. There are some grounds for suspecting that up to at least the beginning of the century birding may have kept the royal albatross populations at a lower level than at present. Photographs taken in the 1930 s at the Forty-Fours show densities similar to those found today. The establishment of a colony at Taiaroa Head and the continuing inflow of immigrants to that colony, plus an indicated correlation between breeding failure and nesting density in the Chatham populations, suggest some level of over-population.

While present populations of the royal albatross may support pressure for a resumption of birding, the justification of such a form of management poses both supervisory and legal problems.

THE FOOD OF OCEANIC BIRDS

M. J. Imber
scientist

In general terms, we have known that oceanic birds, such as petrels and albatrosses, feed on squids, fish, crustaceans and a few other marine animals, but little detailed information has been available. This has been due to the scarcity of observations of the birds actually feeding, and the difficulties of obtaining and identifying stomach contents. Most oceanic birds apparently have a rapid digestive rate and specimens collected at sea, or cast ashore dead on beaches, almost always have stomachs empty except for a few digestion-resisting fragments such as squid beaks. However, in recent years there have been major advances in techniques for the identification of the prey of marine predators, using the beaks of cephalopods (squids and octopuses) and the otoliths of fish.

During studies of the breeding biology of petrels I have had opportunities to collect food samples from several species. On Whale Island in the Bay of Plenty I found that grey-faced petrels often regurgitated when handled and many samples were collected while fledglings were being banded. On Little Barrier Island neither Cook's petrels nor black petrels regurgitated during handling but many are killed by feral cats and stomach samples were obtained from corpses. Additional samples were collected from Cook's petrel chicks by using a stomach tube. Samples from other species were mainly obtained from birds taken for museum specimens but a few were regurgitated.

The identification of food items was not easy. Some cephalopods were identified in the flesh by Dr R.K. Dell of the National Museum but most were so digested that only their beaks remained. Dr M.R. Clarke of the Marine Biological Association of the United Kingdom, who developed a system for identification of cephalopods by their beaks, gave me considerable assistance in sorting out nearly 1,000 pairs of beaks collected from grey-faced petrels. This collection, in conjunction with illustrations of cephalopod beaks scattered through the scientific literature, was then used in identifying beaks from other petrels and albatrosses. Fish were also in a very advanced stage of digestion but J.M. Moreland of the National Museum was able to identify several to family level. The otoliths of fish, like the beaks of squid, are the part most resistant to digestion and are sometimes found in food samples, especially from gizzards. I used them in analysing samples from Cook's and black petrels and albatrosses. The crustaceans were easier to identify because they have an exoskeleton which is somewhat resistant to digestion, and which is the basis for identification. Most of the crustaceans were soon identified by Dr J.C. Yaldwyn of the National Museum.

The food of grey-faced petrels was found to comprise cephalopods (both octopuses and squids) of about 40 species, fish belonging to six families, and at least 14 species of crustaceans, mostly large red prawns. Most of the food taken by Cook's petrels was similar to that taken by grey-faced petrels but smaller. That Cook's petrels should prefer smaller prey is to be expected as they are about one-third the size of grey-faced petrels. The black petrels had fed mainly on squids, occasionally on fish, but rarely on crustaceans. Studies of the feeding habits of other species revealed that crustaceans are most important in the diet of the smaller oceanic petrels, and squids are of greatest importance to the larger petrels and albatrosses. In general, the medium-sized species had the most varied diet which probably explains why these are the most abundant seabirds.

A major conclusion from this study is the prevalence of nocturnal feeding. Nearly all the prey taken by oceanic petrels and albatrosses exhibit the phenomenon known as diurnal vertical migration - the habit of marine animals of living at depth by day, apparently to avoid predators, and ascending towards or into surface waters at dusk, probably to feed. Most food in the sea originates at the surface where photosynthetic phytoplankton grow, so there has to be a mechanism whereby food grown at the surface can be transferred to the food chain in the depths of the sea. Diurnal vertical migration of marine fauna seems to achieve this and in most of the world's oceans this migrating fauna makes up a high proportion of the total mass of animal life in the sea.

Deep-water trawling has confirmed that many fish, squids and crustaceans can be captured at much shallower depths at night than by day. This does not mean that these animals come right to the surface; probably only a small proportion come into that zone where seabirds can capture them. But sufficient do so to make this fauna an important source of food for oceanic birds in tropical and temperate seas. In polar seas this phenomenon may not be so apparent. Except in high latitudes, nocturnal feeding is probably widespread among oceanic birds that feed at the surface. Daytime feeding is limited to scavenging, or the chance encounter with a surface-living animal, especially small fishes driven to the surface by predatory fish. This explains the scarcity of observations of oceanic birds feeding.

How, then, do petrels and albatrosses locate their prey? Some of the shallower-living species have probably arrived at the surface by dusk, and where these are available there is likely to be much feeding around dusk and dawn. However, between 80% and 100% of the fish, squids and crustaceans which form the main prey of the oceanic birds I have studied possess light organs and it seems that deeper-living animals arriving at the surface in darkness are detected by their bioluminescence.

This research into feeding habits has concentrated on cephalopods because these animals are eaten by most oceanic birds, are the most important prey of many of them, and their beaks are more resistant to digestion than any other part of any prey. The collection of beaks from the petrels and albatrosses shows that at least 60 species of squids and octopuses are taken around New Zealand. These range in average size from about 500 gm or less for albatrosses to less than 100 gm for petrels. In general, the birds seem to prefer the largest squids that they can swallow

whole. Specimens of these deep-sea squids are notoriously difficult to obtain by present fishing techniques, and many that are rare in oceanographic and museum collections are regularly eaten by seabirds. Paradoxically, one species of squid which is known to be abundant around New Zealand (and attracts many Japanese fishermen), is unimportant in the food of many petrels and albatrosses. This can be explained, however, by the fact that it is not bioluminescent.

CHATHAM ISLAND BLACK ROBIN

J. A. D. Flack
scientist

As described in an earlier issue (Wildlife 1971-A Review), we are attempting to gain the knowledge necessary to develop methods of establishing the black robin on islands other than its sole habitat on Little Mangere in the Chatham Group.

The population

As a result of seven visits to Little Mangere Island since March 1972, some key features of the biology of this species can now be outlined.

On a visit of 30 hours in late March 1972, information on feeding stations was obtained, and nine birds, including several juveniles, were banded. Breeding success appeared to be relatively good.

The next visit, in January and February 1973, lasted six days, and four birds were banded. Observation of colour-banded birds enabled us to estimate that the population consisted of about 18 birds, including only one known juvenile. Apparently breeding success had been poor that year.

During another six day visit in October 1973 we found that the total population consisted of six pairs and four batchelor males distributed in ten territories. Only two of the four territories occupied solely by males appeared adequate to support pairs. It would seem that the small size of the island and the condition of the habitat restrict the maximum possible number of territories to ten, of which eight are capable of supporting breeding pairs. Laying by the black robin had not begun by October 13, although all the other passerines on the island were breeding.

A seven-day visit in late November and early December 1973 enabled us to obtain breeding data. When we arrived a total of three juveniles had just fledged in two territories, but two of

these were obviously weak. Nestlings were found in one territory and suspected in another (this was confirmed on a later visit). In two territories females were finishing nests or about to lay. Observations of nest building and care of nestlings and juveniles greatly enhanced our knowledge of the behaviour of the species.

On a visit of eight days in January 1974, we found two independent juveniles and a total of three recently-fledged juveniles in two territories. As in December, a weak juvenile was observed with a vigorous sibling. Further data on territory, moult, and the probabilities of recovering banded birds were gained.

Two short visits, primarily to plant trees, were made by W. Brown on the 13 and 22 April 1974. Twelve different adults and two immature robins were seen.

During the season, four pairs each produced a single vigorous juvenile and two pairs failed to breed. One pair nested successfully twice. Only between nine and twelve eggs were laid, although our present information suggests that there was the potential for twenty four. Lowest breeding success occurred in territories where habitat was obviously poor.

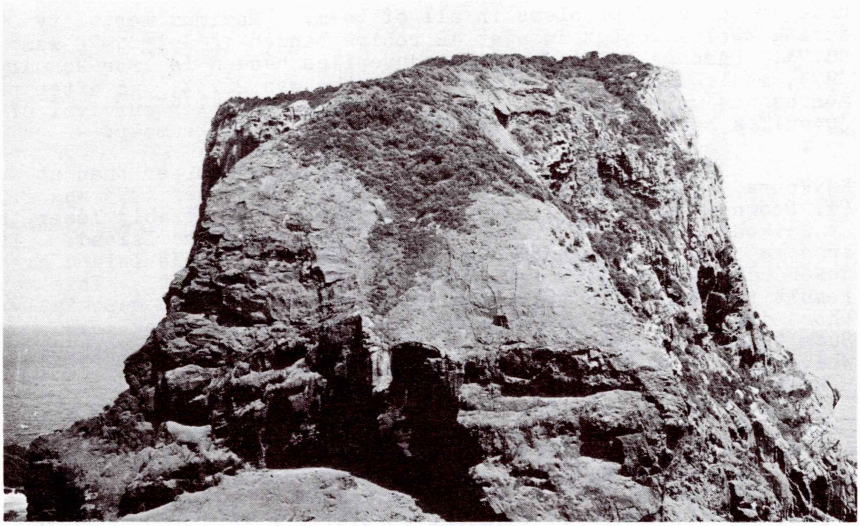
The maximum adult mortality from January 1973 to January 1974 was 29.4% (5/17), a figure near the middle of the range for South Island robin populations. The only known juvenile in January 1973 did not survive, in contrast to the previous year when several juveniles were recruited to the population.

When compared with South Island robins being studied at Kaikoura (Wildlife - A Review No.4), and with the very dense population of Outer Chetwode Island, which is free of mammals, production is extremely poor at every stage. At Kaikoura and on Outer Chetwode Island, the proportion of the population breeding is very high, each pair generally nests more than once, breeding failure is low, and weak young are rare.

There is no evidence that territorial conflicts are unusually frequent or stressful on Little Mangere Island; in fact, the evidence supports the conclusion that most pairs contend with neighbours less than on Outer Chetwode Island. It appears that the food supply on Little Mangere is limiting breeding success.

Habitat

The distribution of dead and dying woody plants on deep soils, the existence of large areas of forest soils completely bare of woody cover and the poor regeneration of woody species, indicate that habitat for robins has been degenerating on Little Mangere Island for several decades or longer. Black robins are not commonly seen hunting in areas with little or no woody cover and it is very probable that the decline in vegetation has meant the loss, so far, of two or three territories.



The eastern end of Little Mangere Island. Note the small amount of woody vegetation.
Photo: D.V. Merton.

Both the dispersion of woody cover and the condition of the litter and soil seem to be major factors affecting availability of food insects. The two territories in which breeding failed are characterized by discontinuous patches of scrub on very steep slopes, and two of the batchelor territories are of even poorer structure than these. In most places the soil is bare and pockets of litter are small. Samples of litter show that a poor fauna of macro-invertebrates exists where there is a heavy concentration of breeding sooty shearwaters. This occurs in eight of the ten territories. Areas where the ground is less disturbed have greater numbers of invertebrates of the sizes taken by black robins (P. McColl, pers. comm.). Dr I.A.E. Atkinson, Botany Division, D.S.I.R., visited Little Mangere in October 1973 to describe and map the vegetation and study the rate and causes of habitat loss.

Outer Chetwode Island

To supplement the information being obtained from the Kaikoura and Little Mangere populations, studies have been extended to a South Island robin population on an island where mammals are absent. Outer Chetwode Island at the mouth of Pelorous Sound in Cook Strait was chosen because it was reasonably accessible, and had a large population in a small area. Since 1972, visits have been made to estimate the size, density, mortality patterns, productivity and recruitment of the population.

It is too early to say much about this population, but it clearly functions differently from those at Kaikoura and Little Mangere, and these differences are providing some -

understanding of problems in all of them. Maximum mortality during twelve months amongst 42 robins banded in July 1972 was 16.7%. Amongst 19 independent juveniles banded in late January 1973, maximum mortality after six months was 26.3%, and after ten months was only 31.6%. A small sample shows lower survival of juveniles between leaving the nest and the first summer.

The breeding season is considerably shorter than at Kaikoura, and clutch size for 21 nests in September 1973 was 2.0 (W. Brown, pers. comm.). Productivity is considerably lower than at Kaikoura, but much higher than on Little Mangere Island. It appears that the small territories on Outer Chetwode Island are defended by the adults only with considerable effort. This may result in disruptions to normal breeding activities, especially those directed towards egg production and care of nestlings. Such intra-specific stress is much less noticeable at Kaikoura where territories are usually large.

The annual adult mortality at Kaikoura (23-37%) is higher than on Outer Chetwode Island. Several types of evidence suggest that the habitat at Kaikoura is as good or better than on Outer Chetwode Island, and the difference in mortality could be a measure of the loss of adults to mammalian predators. Another important difference between the populations is that throughout the year on the island there appears to be a number of non-breeding birds attempting to establish themselves in habitat suitable for breeding. Surplus birds are not found at Kaikoura except for a few months following the breeding season. The birds that are excluded from the breeding population exist in various marginal habitats on Outer Chetwode Island, while at Kaikoura they die or emigrate.

The settling patterns for juveniles and immatures are, consequently, different and have an important influence on population density and stability. Further work is required to confirm the data and substantiate the suppositions.

Robin transfer experiments

Two transfers each involving eight South Island robins were made in 1972. Both failed to establish new populations. In 1973, two transfers of five birds each resulted in the establishment of four breeding pairs of South Island robins on two islands.

The first transfer was made during the summer of 1972 from Kaikoura to a 24 hectare patch of bush surrounded by farm land near the Conway River. Seven birds were released in good condition, and some of them were heard singing soon after. The eighth bird was moved separately on a hot day and died during the short transit period. Both juveniles and adults were moved, but all seemed to disperse away from the patch of bush soon after release.

The second transfer was to Maud Island in Pelorus Sound from Outer Chetwode Island during April 1972. Most of the birds were adults, and their condition on release varied from good to obviously stressed. Weight loss varied from 1.5 to 2.5 grams and averaged 1.8 grams. The birds were held captive from two to six hours. Some were seen drinking from a stream soon after release and the majority, including all stressed birds, were resighted

over several months following release. Some of the birds were observed at considerable distances from the release point, and out of line of sight of the 12 hectare patch of forest. Only one bird persisted for a long period near the release point.

Several factors could have contributed to the failure of these two transfers, the most important being the type of habitat at the release points. On Maud Island, the mature forest is radically different in structure and composition from the youthful regenerating scrub on Outer Chetwode Island. There is little understorey growth except around margins and much of it is on very steep, rocky soils. The isolation of the bush and the island itself appear to have slowed dispersal from the release point. At the Conway release site, much of the habitat seemed good, although the forest was dominated by large podocarps and was radically different from the manuka scrub from which the birds came. In this case, barriers to dispersal were much less than on Maud Island, and we surmise that most of the birds soon dispersed. It appears that survival was initially high in both transfers.

For the Conway transfer, birds were carried in various dark boxes covered with cloth, while for the Maud transfer padded dark boxes were used with two to four birds in each large compartment. These arrangements did not provide adequate ventilation and where birds were together there was some fighting even in the darkness of the boxes. For the next two transfers, small wooden boxes were made with a perch, large ventilation holes, and lighting below the perch so that the food and water provided could be seen. The birds remained quiet during car and launch journeys of up to eight hours and fed at intervals. As a result, weight losses during the two transfers were reduced to averages of 0.9 and 0.2 grams. Overall, the weight change ranged from +1.0 to -1.5 grams.

The two successful transfers each involved five birds released onto isolated islands covered in young regenerating scrub dominated by Leptospermum species. The first of these was made in early March 1973 with three juveniles and two adults being taken from Kaikoura to Allports Island (16 hectares) in the Marlborough Sounds. One adult male disappeared, but the three juvenile birds and one adult female established themselves as two pairs on opposite sides of the island. Nest building began in mid-August and the first nestlings were banded on September 25. Seven juveniles were produced from five nests, one of which was predated. The only mammals on the island are mice but moreporks and harrier hawks are present.

The last transfer was made from Inner Chetwode Island to Motuara Island (56 hectares) in the Marlborough Sounds in mid-July 1973. Ageing of birds was not possible, but research on Outer Chetwode Island shows that most or all would have been at least in their second year. Within five or six weeks, the two pairs that formed were nest building, and the first young were banded in the nest on September 25. The fifth bird, a female, has not been seen, but could easily have been missed in the extensive scrub. Future transfers should include extra males, rather than females, as they are likely to set up batchelor territories and will adopt juvenile females soon after their independence.

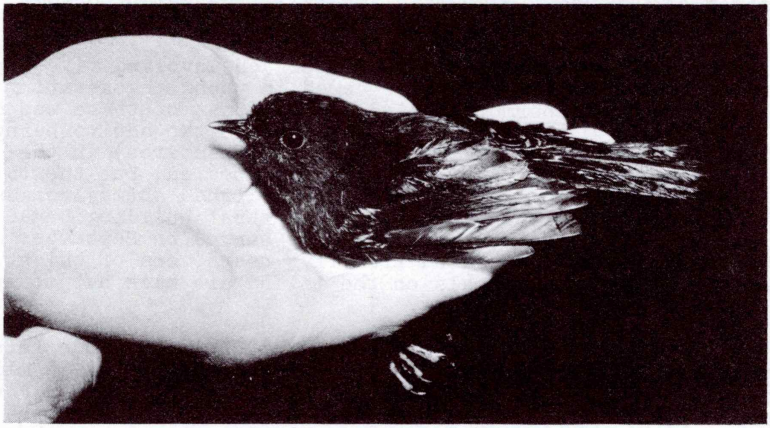
On Motuara Island, both pairs nested three times but only three nests were successful. Three nests were predated and this is attributed to Polynesian rats (kiore) which were particularly numerous on the island in 1973. In one instance, where old nestlings were killed, they were partially eaten in the nest. Only five juveniles resulted from the successful nests because in two nests, built by the same pair of birds, embryos did not form in a total of four eggs. This extremely high degree of infertility for a single pair has also been recorded for one pair at Kaikoura.

It is of interest that clutch size has been much higher on Allports and Motuara Islands (2.7 for 7 nests) than on Outer Chetwode Island (2.0 for 21 nests) where population density is high. Breeding began at the same time on all three islands, much later than at Kaikoura.

Although the released pairs range over areas of indefinite size, most nests have been clustered in small areas, usually close to the release point. These populations will be followed closely for comparison with Outer Chetwode and Kaikoura populations.

Future Management

For some time now the transference of black robins to other islands has been considered essential to the survival of the species. We are now drawing into a position where we will have enough information to develop a plan to do this. A large proportion of the present population cannot breed and there is reason to believe that other islands will provide better habitats.



Chatham Island black robin about to be released after banding. Photo: D.V. Merton.

Transfer experiments in Marlborough Sounds with South Island robins have demonstrated the feasibility of establishing new populations with liberations of as few as five birds.

Removal of that many would not decrease the reproductive potential on Little Mangere, and would probably result in an increase in the survival of independent juveniles.

We propose eventually to move two females and three or four males from marginal territories on Little Mangere to Mangere Island about six weeks before the breeding season, when a suitable area for them has been developed.

South-East Island, which provides the only other apparently suitable habitat in the Chatham group, almost certainly would support a large population of robins, but we believe that the initial transfer should be made to Mangere in order to reduce or eliminate risks. These risks include losing the birds in several hundred hectares of bush on South-East Island, potential competition from the very large and dense tomtit population there, and the difficulties in the transfer itself.

The present forest remnant on Mangere is small but a much larger area is regenerating. The Wildlife Service is now interplanting, and planting on other parts of the island, to speed the development of about eight hectares of native forest and scrub. Planting will be extended as close to Little Mangere as possible to enhance the chances of black robins establishing themselves.

On Little Mangere experiments are being made to determine the feasibility of revegetating open areas by planting native shrubs and trees. Drought and the heavily burrowed soils have been serious hindrances.

MANGERE ISLAND

B. D. Bell

senior fauna conservation officer

The Wildlife Service has pressed for effective protection of the flora and fauna of the Chatham Island group for many years but in spite of the outstanding biological interest of these islands, no areas were given any official protection until South-East Island was reserved in 1954. Since then, only one other major reserve, Mangere Island, has been established.

South-East Island, although modified by fire and introduced animals, retained most of its indigenous species and 10 of the 16 extant Chatham Island birds are present there. Since sheep were removed in 1961 the vegetation has regenerated rapidly. Mangere Island, however, has had a less happy history. When purchased by the Government in 1966, with the aid of a considerable financial contribution from the Royal Forest and Bird Society, very little forest remained. Grazing and browsing by sheep, goats and

rabbits had begun before the turn of the century and fire, and wind penetrating the damaged forest, contributed to the island's degradation. Cats introduced in the 1890s to control the rabbits almost certainly contributed to the local extinction of 12 species of birds, namely the Chatham Island tui, Chatham Island pigeon, Chatham Island yellow-crowned and red-crowned parakeets, white-faced storm petrel, southern diving-petrel, Chatham Island snipe, New Zealand shore plover, Chatham Island bellbird, Chatham Island robin, Chatham Island fernbird and the Chatham Island rail.

New Zealand shore plover. Photo: J.L. Kendrick.

Fortunately, the cats apparently dealt with the rabbits and later died out themselves, allowing two species which were formerly present, white-faced storm petrels and red-crowned parakeets, to recolonise the island. Goats were removed by the former owners and, when Mangere Island was declared a flora and fauna reserve in 1967, sheep were the only introduced mammals that remained. These were exterminated by the Wildlife Service in 1968 when 250 were destroyed.

Regeneration of the bush following the removal of grazing mammals has been slow but the grassland has flourished and many rare herbacious plants, among them Myosotidium hortensia and Aciphylla dieffenbachii have again become numerous. Burrow-nesting sea birds, the sooty shearwater and broad-billed and fairy prions, have increased in numbers and have colonised new ground now no longer trampled by the hooves of sheep.

The Wildlife Service has taken further steps in the long process of turning the clock back on Mangere by re-introducing species which once flourished there. This activity started in November 1970 when 23 Chatham Island snipe and 15 shore plover were transferred from South East Island. The liberation of snipe coincided with a heavy grass grub infestation in the rank pasture

which provided an ideal food source and snipe have now colonised most parts of the island - nests and young chicks were seen within a year of release.

Remnants of the original cover on Mangere Island.
Photo: D.V. Merton.

The shore plovers did not become established. They deserted the island soon after release and returned to their original home 11 kilometres away. A further attempt was made the following year using sub-adults but in spite of the birds' flying ability being restricted by the removal of some flight feathers they still returned to South East Island. Studies are planned to try to find ways of overcoming this strong orientation to their ancestral home.

One of the main purposes for reserving Mangere Island was to allow it to become once again a suitable habitat for the black robin and the Chatham Island yellow-crowned parakeet, both of which are at present confined to neighbouring Little Mangere Island. As the natural regeneration of vegetation is very slow a planting programme designed to provide suitable habitat, particularly for the black robin, has begun. This calls for the initial establishment of a minimum of eight hectares of close-canopy scrub some one to two metres in height, a task which will involve the planting of about 100,000 rooted cuttings over a period of three to four years.

To "tighten up" the existing bush, 4,000 akeake (Olearia traversii) cuttings taken from trees on the island have already been planted. A further 15,000 cuttings were brought back to the mainland for propagation at the New Zealand Forest Service nursery at Sweetwater, Kaitaia. In addition, the Ministry of Works and Development nurseries at Wellington and Christchurch are each propagating 5,000 cuttings from local stock. This will mean that 25,000 rooted cuttings will be available for planting by April 1975.

To boost growth rates the planting of flax to provide windbreaks has been started. Some 1,800 plants have been cut from plantations on the Weisner Brothers' farm in the north of the main Chatham Island and transported to Mangere Island by fishing boat. This local flax is a more vigorous strain than that found in New Zealand.

This major regeneration project should go a long way towards helping Mangere Island to return to something like its former state: but more important we hope that it will provide the answer to the survival of the Chatham Island robin and the Chatham Island yellow-crowned parakeet. In addition to providing for rare species, it will also be a habitat for all bush birds which occur on the Chathams.

RAOUL ISLAND

J. C. Smuts-Kennedy

fauna conservation officer
WHANGAREI

The Kermadec group, of which Raoul is the largest member, shares a similar latitude, climate, geology, bird fauna, and to some extent vegetation, with Norfolk Island. It comprises something over a dozen islands stretching in a N.N.E. - S.S.W. line 235 kilometres long straddling the 30° parallel. Raoul is at its farthest end over a thousand kilometres north-east of Auckland.

Discovered by the French in 1793, Raoul was the haunt of sperm-whalers in the early part of the following century, and various attempts at settlement were made between 1837 and the second world war. The Kermadecs were annexed to New Zealand in 1887 and shortly after this there were reported to be over 45 settlers on Raoul Island. The group was gazetted as a flora and fauna reserve in 1934 with the exception of a small freehold block on the northern coast of Raoul owned by the family of a well-known settler, Thomas Bell. In 1937 this block was purchased by the Crown and a permanently manned radio and meteorological station established.

Raoul is a roughly triangular forest-covered active volcano approximately 9 kilometres by 6 kilometres with an approximate area of 2,900 hectares. Its highest point, 514 metres, is on the rim of a volcanic crater about 2.4 kilometres in diameter in which are three lakes. Three volcanic eruptions have been recorded, the most recent in 1964. Most of the coast-line is boulder-beach, backed by cliffs up to 250 metres high, with a few sand and gravel beaches. Generally, the island is very rugged with little flat land.

The climate is sub-tropical with temperatures ranging from an average of 16°C in the winter to 22°C in the summer. Humidity is generally high.

Both the Polynesian rat (kiore) and the Norway rat are present on Raoul. Feral goats have been present since about 1842 and feral cats were first observed in the 1860s. The goats have greatly modified the vegetation, and the cats and rats have seriously reduced, or elimated, bird populations.

Raoul Island. A view across the volcanic crater and the Green and Blue Lakes.

Photo: C.R. Veitch:

Raoul is the only island in the Kermadec group large enough to support a full representation of Kermadec endemic plants. The main canopy tree is the Kermadec pohutukawa (Metrosideros kermadecensis) which is highly palatable to goats. Regeneration is therefore very restricted, and when the present trees die off the vegetation will obviously be drastically modified. The understorey is already very different from that described by Oliver in 1910 when the endemic Coprosma acutifolia was recorded as being one of the most common understorey species; it is now rare. The two endemic tree ferns (Cyathea kermadecensis and C. milnei) are becoming harder to find and the endemic taupata (Coprosma petiolata) is now very rare on Raoul. Several other endemic plants are much reduced and Hebe breviracemosa is probably extinct.

Some native plants less palatable to goats have benefited, but so have some undersirable aliens. The African olive (Olea africana), purple guava (Psidium littorale) and Mysore thorn (Caesalpinia decapetala) are all rapidly invading

the bush, and chemical and mechanical methods of eradicating them are under way. The aroid lily (Alocasia macrorrhiza) introduced by Niue Island workers for food has passed the stage where eradication is possible, and its large leaves in many places completely over-shadow the forest floor and inhibit seedling growth.

The black-capped petrel, black-winged petrel and wedge-tailed shearwater once bred on Raoul in good numbers. The first two are now absent and the wedge-tailed shearwater is found only in very small colonies. The most spectacular decrease was that of the Kermadec petrel the young of which were once taken as "mutton birds" by the settlers (12,000 recorded as being taken in one year). In some areas their density was reported as 800 nests per half acre, and the adult birds "darkened the sky". They are now absent from Raoul.

Kermadec petrel. Photo: D.V. Merton.

The first Wildlife Service visit to the island was in 1954 and this resulted in a recommendation that the goats be eradicated. The following year a Forest Service team of two men accounted for 1,422 goats and 45 cats, with an estimated 300-400 goats still remaining. In 1966/67 an expedition organised by the Ornithological Society of N.Z. spent 10 weeks on Raoul and estimated the goat population to exceed 3,000. This expedition recommended that the goats and cats be eradicated.

In the winter of 1972 an eight man team representing the Wildlife Service, Forest Service, Lands and Survey Department

and the D.S.I.R. spent seven weeks on the island and destroyed 1,286 goats and 61 cats. It was estimated that approximately the same numbers of both survived. The following year a four man team from the Wildlife Service and the Forest Service spent fourteen weeks on the destruction of goats and 627 were destroyed, plus 15 cats.

In 1974 the Wildlife Service (with the help of the Lands and Survey Department, Forest Service and D.S.I.R.) will again send an expedition to Raoul to destroy goats and cats. The expedition, planned for September, will occupy a party of eight men for three months.

Goats are hunted on foot with dogs and rifles, but prove difficult to approach on the high coastal cliffs. Other methods may be used in the future.

Goats have been completely eradicated from several other islands, including one other in the Kermadec group, but none as forested, large or as precipitous as Raoul. However, total extermination should be possible, provided the regularity of expeditions is maintained.

Last year there was already some regeneration of a few of the rarer native plants which is encouraging and indicates that at least some of them will recover fairly quickly once the goats are gone.

Fortunately, all the petrel species which have been depleted, or elimated from Raoul, breed on other islands in the Kermadec group and, when conditions improve, may move back to their old haunts. Kermadec parakeets and spotless crakes also occur elsewhere in the group and parakeets from Meyer Island regularly attempt to re-colonise Raoul.

Rats are virtually impossible to eradicate by known methods whereas cats are not, as has been proved on Kapiti (over 2,000 hectares) and other islands. Methods used so far on Raoul to remove cats are trapping, shooting and dogging. Poisoning will be considered if necessary. The question of rats "taking over" once cats are removed has been raised but this is unlikely as the island does not support a high number of cats. Even if it did the rat population would still be regulated by food availability.

Raoul is yet another example of an island where biologically-important values have been depleted by man's interference and indifference. However, if the present management programme is successful it may yet be possible to preserve much of its unique character and so enhance the role of the Kermadec group as an important biological reserve.

ISLAND SURVEYS

C.R. Veitch

fauna conservation officer
AUCKLAND

Since D.V. Merton first wrote about island surveys (Wildlife 1969 - A Review), work on island groups about the northern half of the North Island has continued and 158 islands have now been surveyed in this region.

Besides their outstanding value as last refuges for a number of endangered, or rare, terrestrial birds, reptiles and invertebrates, islands are the only breeding places of the majority of our seabirds. Since many species of seabirds are generally more active on the islands, and therefore more conspicuous, early in their breeding season, surveys are usually restricted to that period of the year. Other work requirements further restrict us so that the surveys have taken place mostly during the month of November. It has been found, however, that it is possible at this time of the year to obtain the necessary basic information on the islands and their occupants.

The collection of data is standardised and simplified by the use of a three-page form on which is recorded basic physical and biological information describing, among other things, land form and geology, past and present human activity, location of landings and ease of landing, vulnerability to fire, and the flora and fauna. Recommendations are made concerning the need for further surveys of a more specialised nature and possible conservation measures.

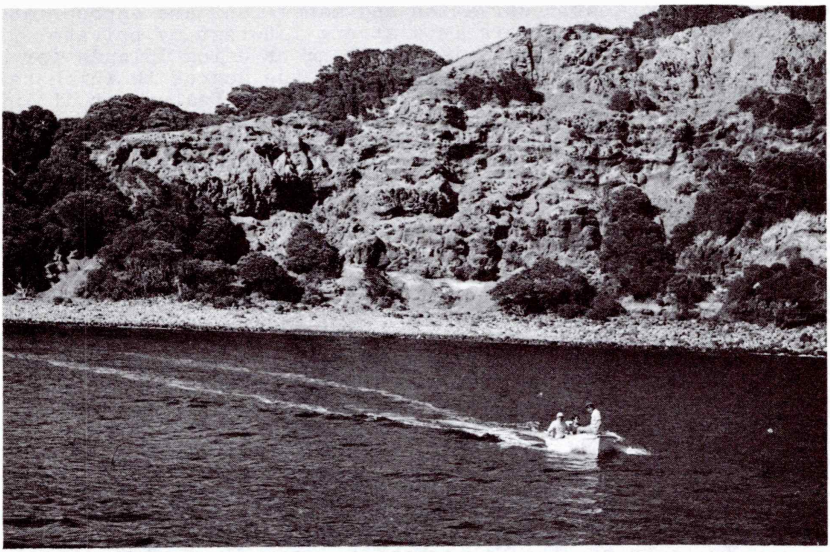
Northern islands, or groups, surveyed during the last three-year period include the Poor Knights, Chickens, Mokohinau, Motukawao, Coromandel, Mercury, Aldermen, most islands in the Bay of Plenty and all those in the Bay of Islands. This means that practically all islands off the east coast of the North Island have now been surveyed. The remaining few, generally very small or mere rock stacks, will be visited as soon as possible so that a complete report can be published.

Of the 158 individual islands surveyed, the 78 which were recorded as being of significant wildlife value included 50 which have suffered no significant recent modification by man and have no introduced mammals, seven which have the Polynesian rat (kiore) but are otherwise unmodified, and 21 which have been modified by burning or introduced animals but are now returning to a natural state (except that most have kiore). The various factors which contributed to the rating of 80 islands as having no significant wildlife value included extensive alteration by farming and burning; the presence of introduced animals, particularly the Norway rat and ship rat; inadequate size as in

the case of small, sea-washed rock stacks; and the lack of any plant or animal not adequately represented elsewhere. Any of these factors does not, in itself, of course, always mean that an island is regarded as having no significant wildlife value. The possibilities of rehabilitation are always taken into account.

A lot more information about the distribution, abundance and ecology of many species has been gathered. Two small islands were found to have previously unrecorded tuatara populations and further information concerning the distribution of tuatara, lizards and small petrels in relation to the distribution of kiore was obtained. Where kiore are present, tuatara, small lizards and the smaller petrels are either absent or in very restricted numbers.

The Aldermen is a particularly valuable group which was given to the Crown by its Maori owners at the time of the last visit to New Zealand by H.M. the Queen. It is here that the most graphic evidence of the effect of kiore on tuatara can be seen. Despite all the larger islands having been burned within the last 70 years tuataras have survived in good numbers except for where kiore are present. Even some of the very small islands and rock stacks hold good populations of tuataras in the absence of rats.



A survey party leaving Red Mercury Island.
Photo: D.V. Merton.

The impact which alien mammals are capable of having upon an island ecosystem is well illustrated on islands of the Mercury group. These islands show significant differences in flora and fauna brought about by the presence or absence of

various introduced mammals. Middle and Green Islands are virtually unmodified but highly vulnerable to damage because their soils are honeycombed with petrel burrows. Apart from Great Mercury, which is farmed, Korapuki is most modified with both kiore and rabbits. Kawitihu has kiore and remnant populations of rabbits. Double Island and Red Mercury have only kiore but the latter island was largely cleared and burned at an earlier date. This group, therefore, offers a unique opportunity to biologists in that its various islands are "living laboratories" where comparisons of the influence of various alien mammals and combinations of these mammals upon the indigenous biota can conveniently be made.

One depressing feature of the surveys is the evidence of damage caused by human agency. Of the 29 islands off the west coast of the Coromandel Peninsula (Motukawao and Coromandel groups) only four have any significant wildlife value. Two, Motutakapu and Motukaramarama, have important gannet breeding colonies and two, Motuokino and Cow, are petrel-breeding islands. The rest have been cleared, or partly cleared, for farming and then neglected. Most have rats, rabbits, possums or pigs, and stoats have found their way to those which are close inshore.

The prime purpose of the surveys is to ensure that due consideration is given to the biological importance of our off shore islands and that reservation and management are appropriate to the circumstances. There is a strong interest by private individuals and organisations in acquiring or using islands for various purposes and it is essential that the degree to which this may be permitted does not jeopardise any unique feature or diminish the overall importance of islands to our natural communities. As individual surveys have been completed recommendations have been made to the appropriate administrating authority, in many cases the Department of Lands and Survey, regarding immediate needs in the form of reservation and management. Further recommendations will be made when all the surveys in a particular region have been completed and assessments can be made on a wider basis.

In the north, recommendations have, so far, resulted in arrangements being made for a number of islands, particularly those off the inner Coromandel coast, to be considered for inclusion in the Hauraki Gulf Maritime Park. Negotiations are also under way to have domestic stock removed from Stephenson Island, which supports important breeding colonies of petrels. Islands off Whangamata, which support tuatara populations but which are close inshore, are being gazetted as wildlife sanctuaries in order to control public access. On Green Island in the Mercury group, boxthorn (Lycium ferocissimum) was eradicated at an early stage of colonisation.

In the past, the Cartographic Survey Team of the Royal New Zealand Navy has made a practice of clearing scrub and forest from the summits of small islands to facilitate the taking of bearings. The vegetation of many of these islands is unique in that it has otherwise been unmodified and its destruction is most undesirable. Discussions with the Navy have resulted in any clearing being reduced to an absolute minimum.

THE CLIMATE OF A FROG HABITAT

I. G. Crook
scientist

Of our three species of native frogs Leiopelma hamiltoni is almost certainly the rarest, occurring as it does on only two small islands in Cook Strait. On one of these (Stephens Island) it is restricted to a boulder bank about 20 metres square which is close to the island's summit. A habitat seemingly quite unsuitable for a frog.

Frogs and toads generally live close to pools or streams or open water of some kind and all require a moist environment to survive. Our native frogs are no exception and the habitat of the rarest of them is the strangest - a most unlikely place for a frog to survive.

Stephens Island was once covered in dense forest and the boulder bank at the top of the island (nearly 300 m above sea level) would have been a cool damp place shaded by many trees. But the forest has gone from the bank and rocks that were once covered in moss are now exposed to sun and wind, and to salt driven by frequent gales.

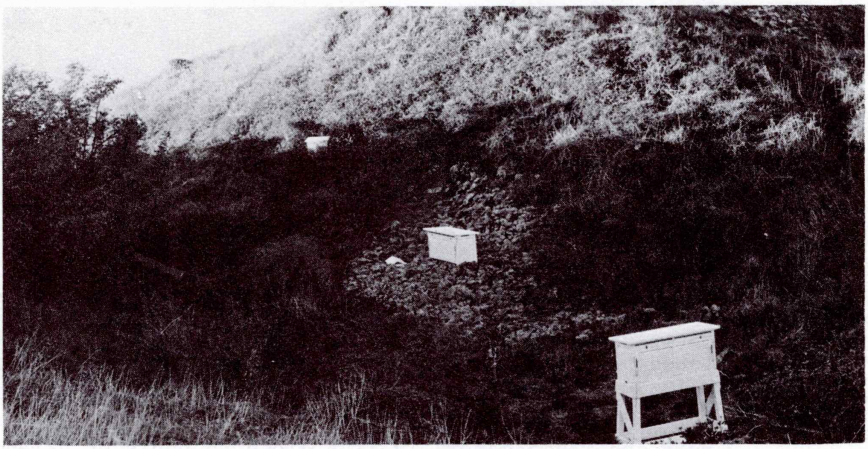
How the frog managed to survive this tremendous change in its habitat is an intriguing question. It is possible that it may be able to find refuge very deep below the surface during dry times. The boulder bank may have been formed by slumping of part of the summit ridge and the broken rock may extend to considerable depths. Alternatively (or perhaps additionally) the bank may be a moister environment than it looks at first sight.

The depth of the broken rock in the bank would be difficult to determine without destroying the tiny habitat altogether, but studies of the climate in the bank and of its immediate surroundings are a practical proposition.

However, such studies require some baseline for comparison - the absolute limits of the frog's tolerance of dryness for example or similar measurements of the climate of another habitat. Twenty miles south of Stephens Island is Maud Island, where the only other population of the frog inhabits a forest remnant. We have placed one set of instruments in this forest. On Stephens Island, we have placed one set of instruments on the ground in the forest remnant near to the boulder bank, a second on the surface of the rocks of the boulder bank and a third a short way below the surface.

Finally, instruments have been set up under standard

meteorological conditions to more generally compare the climate of the two islands.



Part of the climate-measuring equipment at the Stephens Island frog bank. Photo: L. Moran.

Each set of instruments records fluctuations in such things as temperature and relative humidity and allows comparisons such as those shown in the following table:-

COMPARISONS OF THE CLIMATE INSIDE AND OUTSIDE OF FORESTS ON STEPHENS AND MAUD ISLANDS (FIGURES FOR MARCH 1974)

	STEPHENS IS.		MAUD IS.	
	FOREST	OPEN	FOREST	OPEN
Mean daily maximum temperature °C	14	19	16	19
Mean daily minimum temperature °C	10	12	12	13
Mean daily average temperature °C	12	15	14	10
Mean daily temperature fluctuation	4	7	4	6
Mean number of hours per day when relative humidity exceeds 90%	10	8	7	3

It is too early to come to any conclusion about similarities and differences between the islands and on parts of the same island, but after records have been collected for a year or so we will know just how the climate below the rocks resembles that in the open or beneath the forest on both islands. We will then be able to say more about the conditions needed by the frog to survive and what we must do to ensure that it does.

ARE TUATARAS DEPENDENT ON PETRELS?

I. G. Crook

The islands where tuataras are found are in two main groups, one off the north-east coast of the North Island between North and East Capes and another in Cook Strait. Despite their distribution through five degrees of latitude they have several features in common:-

1. They are relatively isolated and difficult to land on. Not only are most of them bounded by cliffs, they are also subject to rapid changes in the weather.

2. They are often lashed by gale-force winds and salt spray which have marked effects on the vegetation. The less modified ones have forest cover with a high proportion of salt-and wind-tolerant trees such as pohutukawa in the northern group and taupata and ngaio in the southern group.

3. Despite their isolation and the difficulties of landing, humans have played a part on many of them. Maoris commonly burned the vegetation, sometimes relatively recently; and evidence of past fires is found in areas of flax and manuka and kanuka scrub-land, in regenerating forests dominated by pioneer species and, at the very least, in the frequent occurrence of charcoal in soil profiles. Lighthouses have sprung up on several in the last hundred years and on some of these much of the forest has made way for grazing land. Stephens Island in Cook Strait is the prime example of this and it demonstrates that the tuatara can survive on what amounts to farmland.

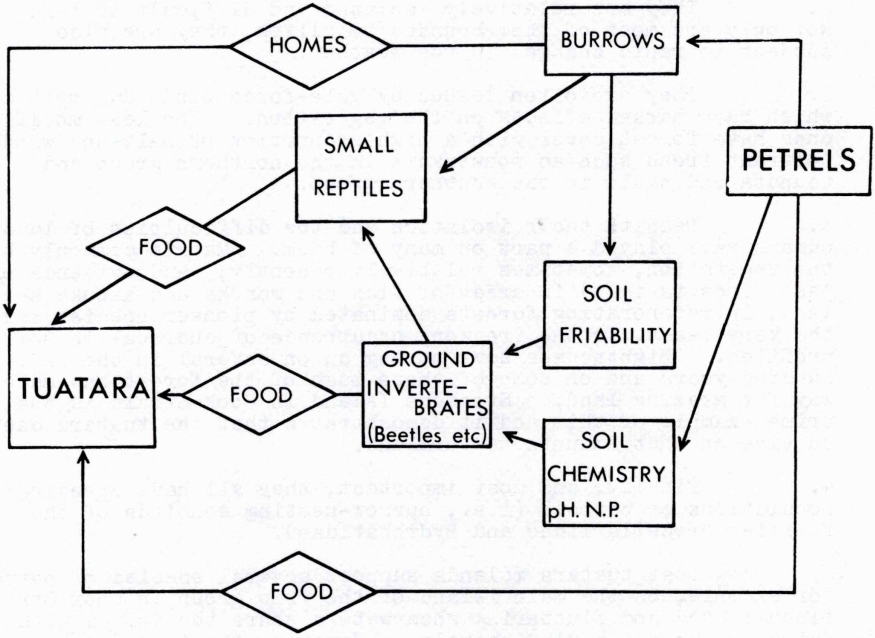
4. Finally, and most important, they all have breeding populations of petrels (i.e., burrow-nesting seabirds of the families Procellariidae and Hydrobatidae).

Most tuatara islands support several species of petrels - for example, on the main island of the Trio group in Cook Strait, flesh-footed and fluttering shearwaters share the island with fairy prions and diving petrels. However, the islands where tuataras are definitely maintaining their numbers, generally speaking those where rats have not established (see Wildlife - A Review No.3), have very large breeding populations of either or both fairy prion and diving petrel. These are the two smallest, widely - distributed petrels in the tuatara's range. Nearly every suitable surface on a tuatara island is riddled with the burrows of one or both of these birds. Three burrow entrances in a square metre of soil is not an uncommon density and petrels are therefore a major part of the tuatara's environment

influencing soils, vegetation and fauna.

The petrels are effective cultivators and fertilisers. They inhibit the growth of ground-cover vegetation, turn the soil over and incorporate plant litter. All this activity which makes the soil very friable, and their mineral-rich guano, may encourage invertebrate animals like beetles and wetas and those animals that live on them, such as small lizards.

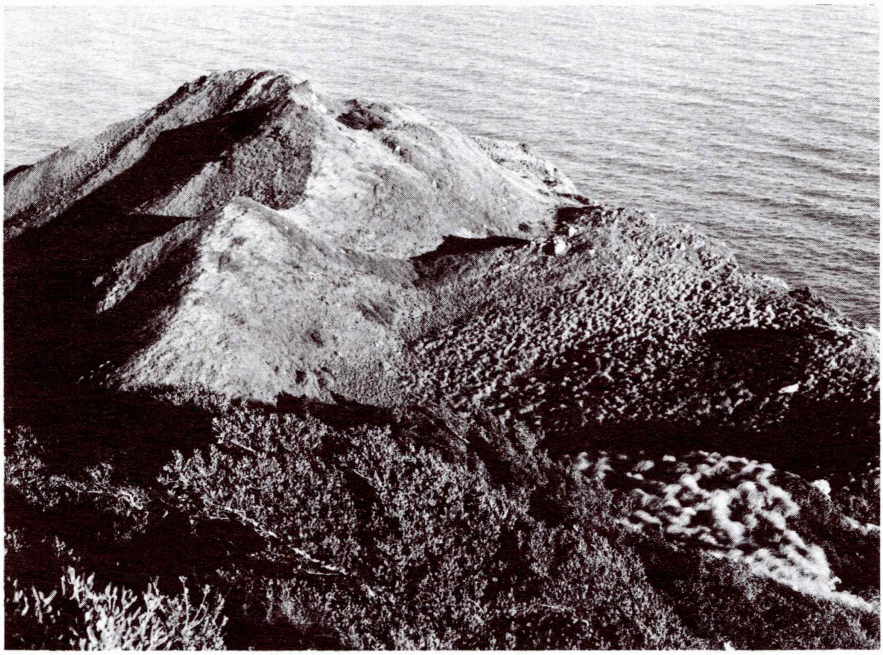
The strict coincidence of tuataras and petrels and their possible relationships have frequently caused comment in the past. Petrels provide the burrows in which some tuataras live, friable soil in which other tuataras may dig burrows, and food. Tuataras eat the adults, chicks and eggs of the smaller petrels and for the rest of their diet rely on invertebrates and smaller reptiles - both of which the birds apparently encourage. Finally, the open ground of islands with large numbers of petrels may provide conditions ideal for the foraging tuatara. These relationships are illustrated below:



From this arises the question: Is the tuatara dependent on petrels for its survival? Restriction of tuataras to islands with petrels is too complete to be just a matter of coincidence, but the survival of both is linked with the absence of rats. Islands with rats have few or no tuataras but they also lack small petrels and there is little doubt that predation is the cause of the petrels' disappearance.

Direct predation by rats could also be the cause of the tuataras' disappearance. Rats probably could not attack and kill an adult tuatara, but they could eat the very young animals and dig up and destroy the eggs - which take 13 months to hatch and are not cared for in any way by the adults. On the other hand, but perhaps less likely, the rats may be only indirectly responsible. If tuataras were totally dependent on petrels and the rats exterminated the petrels, the tuataras would, in their turn, disappear. There is a third possibility, of course; tuataras could be totally dependent on petrels for survival and the rats could still be the direct cause of the extinction of both.

The possibility that tuataras may be dependent on petrels has led to a closer examination of the relationships between them. If their occurrence on the same islands is purely a matter of coincidence, and the relationships between them unnecessary for the survival of the tuatara, their patterns of occurrence on one island might be independent of one another. This thought led us to look at the relative numbers of the two on different parts of the same island.



The southern end of Stephens Island. Note the variety of habitat which includes grazed pasture, low scrub and forest. Photo: J.L. Kendrick.

A series of plots has been set up on various parts of Stephens Island. Each of these consistsof two to five quadrats 25 x 25 metres in size and they are sited on soils with burrow densities of from zero to nearly four per square metre. Estimates of tuatara numbers on each plot have shown that over the lower range of petrel activity, tuatara and petrel populations increase in proportion. Over the middle range (one to two burrows per square metre), however, the increase in tuatara numbers flattens off and areas with very high densities of petrels (more than three burrows per square metre) have fewer tuataras than those in the middle range.

A decrease in tuatara numbers with increasing numbers of petrels also occurs locally in areas with an average density of burrows of 0.3 per square metre and over. This was seen by comparing numbers of tuataras in different quadrats on the same plot. Almost invariably the quadrats with the larger number of burrows had the fewer tuataras.

These findings are not proof of dependence but they are indicative of close ecological relationship between birds and reptile and encourage further investigation. They show that areas unburrowed by petrels are also unsuitable for tuataras. The ground in these areas is too hard for either to dig burrows in, but the occasional tuatara is found under rocks and logs. They also show tuataras to be most abundant in areas of moderate petrel density or at the periphery of "colonies" of petrels and suggest that tuataras may require the petrels, or the conditions they create at least, to maintain the very high densities found on some islands.

The apparent inhibition of tuataras at high densities of petrels is an interesting complication, however, which could be the direct result of disturbance by the birds on the surface or underground or both. It shows that not all relationships between the two are favourable to tuataras and it leads us to ask the question: Is there a disproportionate increase in petrel activity with increasing density of burrows? Such an occurrence would mean that areas of high burrow density would have a larger number of petrels milling round per burrow than when burrow densities are lower. This would create the sort of conditions tuataras would seek to avoid.

Counts of petrels on the surface of the ground at the beginning of the breeding season gave an indication that activity might be disproportionately high in areas of high burrow density, and excavations of burrows at the end of the season confirmed it. At high burrow densities nearly 80% of burrows contained nests, but in areas where burrows are sparse the proportion is nearer 20%.

This is where the investigation rests for the moment, on the verge of closer studies of the relationship between tuatara and petrel in the burrow and examination of feeding habits of tuatara in relation to petrel density. Although dependence has not been established there can be no question of the advantage petrels provide in the fields of home and food.

PLACOSTYLUS

J. C. Smuts-Kennedy

Although the Wildlife Service has no direct responsibility for the management of any invertebrate fauna it does not ignore this important component of natural systems and is active in promoting the conservation of some of the larger native species which could be considered endangered. In the Northland region, snails of the genus Placostylus are of particular interest and some time has been spent in assessing their distribution and status.

Although large (up to 8 cm across the shell), Placostylus snails are difficult to find. They are nocturnal and their dark brown colour blends well with the leaf litter under which they hide during the day. They are strictly coastal, apparently preferring to live in a plant association where they can feed mainly on the fallen leaves of karaka (Corynocarpus laevigatus). Despite their popular name of "flax snails" they do not appear to utilise the native flax to any significant extent.

Of the three species of Placostylus, one, P. bollonsi, inhabits Great Island in the Three Kings group. It was at one time considered to be endangered by the influence of goats on its habitat, but since the eradication of goats by the Wildlife Service in 1946 and because of the status of the island as a scenic reserve with access by permit only it is now in a fairly secure position.

Another species, P. hongi, did occur in great numbers along a coastal strip between the Whangarei and Whangaroa Harbours and on some off-shore islands, including the Poor Knights and Little Barrier, to which it may have been introduced by the Maoris. It would seem that it is now absent from the mainland and is restricted to islands. Very large populations are present on the islands of the Poor Knights group and as these islands are protected as scenic reserves this species would appear to be adequately protected.

Being almost entirely restricted to the mainland, the third species, P. ambagiosus, is the most difficult to protect. In the extensive drifting sand areas behind Cape Maria Van Diemen, Spirits Bay and Tom Bowling Bay can be seen very large numbers of its shells, together with the shells of other native snails. This indicates that these areas once provided suitable habitat with the necessary shade, dampness and food and were therefore forest-covered. When these conditions prevailed the snails would

probably have occupied an almost unbroken belt of coastal forest and scrub 56 kilometres long from Scott Point to Parengarenga Harbour. The sand encroachment, which would have been encouraged by man's destruction of coastal vegetation reduced the population to remnants and these have been isolated long enough to form colonies of distinct sub species, ten of which are recognised at present.

Due to continued habitat destruction, trampling by cattle, depletion by collectors and the depredations of rats, wild pigs and possibly stoats and hedgehogs most of these colonies are now in a precarious position. Some number possibly less than twenty individuals and occupy an area of less than a hectare. In recent years, however, the reservation of land has provided better control over access to colonies and opportunities for habitat management.

The one colony of P. ambagiosus not on the mainland is on Motuopao Island off Cape Maria Van Diemen and received additional protection in 1962 when the island was declared a flora and fauna reserve.

In 1964, 683 hectares of Crown land at North Cape were declared a scenic reserve. This protected two more colonies, and some of the unique vegetation associations occurring on the serpentine soils.

The Te Paki Farm Park was established eight years ago with the acquisition by the Lands and Survey Department of Te Paki Station. This 17,000 hectare block stretches from the Te Paki Stream to Spirits Bay and provides protection for three more colonies as well as for another snail, Paryphanta busbyi watti.

Last year the Farm Park was extended by the purchase of 4,384 hectares between North Cape and Parengarenga. This included three more P. ambagiosus colonies and left only one subspecies entirely outside Crown land (another subspecies has two colonies, one inside and one outside the newly acquired block).

The Lands and Survey Department is at present negotiating for a coastal strip of land to join the new block to Spirits Bay. If this is successful, all the known colonies will be on Crown land.

It is proposed to reserve about half the land area of the original Te Paki block (including all the snail areas) and to farm the rest. A full time Reserves Ranger is based at Te Paki and acts as warden of the various snail colonies. Pigs are kept in check by private hunters and stock is being fenced out of the colonies. When all snail areas are reserved it will be illegal for anyone to remove or disturb P. ambagiosus without authority.

Restoration of habitat is the one thing most likely to help P. ambagiosus and apart from excluding stock it may be necessary in some areas to arrest sand encroachment. Given adequate habitat a certain amount of predation by rats could probably be tolerated.

As a last resort the transfer of individuals to new areas in order to establish other colonies could be considered.

FOREST SURVEYS

I. G. Crook

The Forest Fauna Survey Unit came into being on 24 September 1973 and surveys and research became possible which previously had been totally beyond our reach.

To begin with the Unit made a survey of Little Barrier Island at the mouth of the Hauraki Gulf - a chaos of knife-edged ridges and bluffs which was once a volcano. From there it moved to Kapiti Island off the west coast of the North Island near Wellington, where particular attention was paid to testing methods of determining distribution of kiwis (two species are present on Kapiti) as well as making comparisons of its bird fauna with that of Little Barrier. The series was completed with surveys of eleven blocks of forest included in proposals to exploit beech forests on the West Coast of the South Island. These were in five major areas: on the western fall of the Paparoa Range in Charleston State Forest, on the eastern foothills of the same range in the area known as Fletcher Creek (Inangahua West State Forest), the forests immediately south of Reefton (Tawhai State Forest), on the eastern slopes of the Victoria Range (Maruia State Forest), and on the eastern side of the Grey Valley in the region of Lake Hochstetter (Hochstetter State Forest). The west coast surveys were aimed at examining a representative range of the forest types found in the project area and comparing their bird faunas.

1. Little Barrier Island

Although some of the forest on the lower slopes of Little Barrier had previously been cut and burned by Maoris the island has been reserved for the protection of flora and fauna since 1896 and it presents as near to primeval conditions as one might expect to find in the modern world. It is thickly clothed from sea to summit (712 m) in dense native forest which botanists regard as one of the best altitudinal sequences of forest existing in New Zealand. This is partly because it covers the range from coastal to subalpine conditions in the one area of only 3,056 hectares. Consequently the vegetation is both rich and diverse; and so is the birdlife - one of Little Barrier's most important distinctions is that it is the only place left where the stitchbird is still found.

The stitchbird is a honeyeater, a member of the same family as the tui and bellbird but smaller than either. It is also one of the relatively few New Zealand passerine birds with distinctly different plumage in the male and female. The male is velvet-black on the head, shoulders and upper breast, has

white ear patches, and a yellow band across the breast. The female is much less colourful being predominantly olive-brown above and a lighter grey-brown below.

The stitchbird was once distributed throughout the North Island, but it declined during the early years of European settlement and became extinct everywhere except on Little Barrier Island. The reasons we do not know, but one of the objects of the Little Barrier survey was to give us a better idea of the types of habitats it requires. A second object was for a survey which could be regarded as a model for the larger ones to come, both in execution and analysis of the resulting information. These two objects mesh closely. One of the major functions of these surveys is to gather information on the habitat requirements of the birds encountered.

The survey followed the pattern previously established in North Island forests (see Wildlife 1970 - A Review). Information describing habitats and a list and count of birds were obtained at a series of stations 500 yards apart covering the whole island. Spacing was maintained in this way so that there were four stations in each thousand yard square of the national grid. This allows distribution of birds (or any other feature recorded) to be mapped as presence or relative numbers in each 250-yard subdivision of the national grid. The distribution of the stitchbird and bellbird as revealed by the survey provides examples of such maps (Figures 1 and 2).

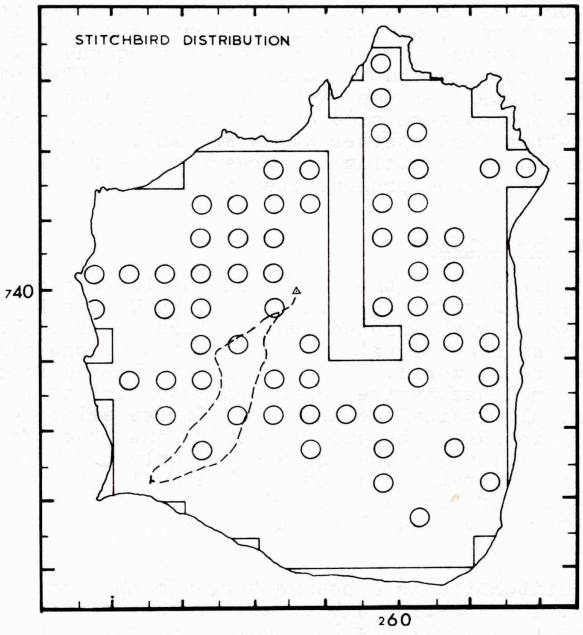


Figure 1. Stitchbird distribution on Little Barrier Island.

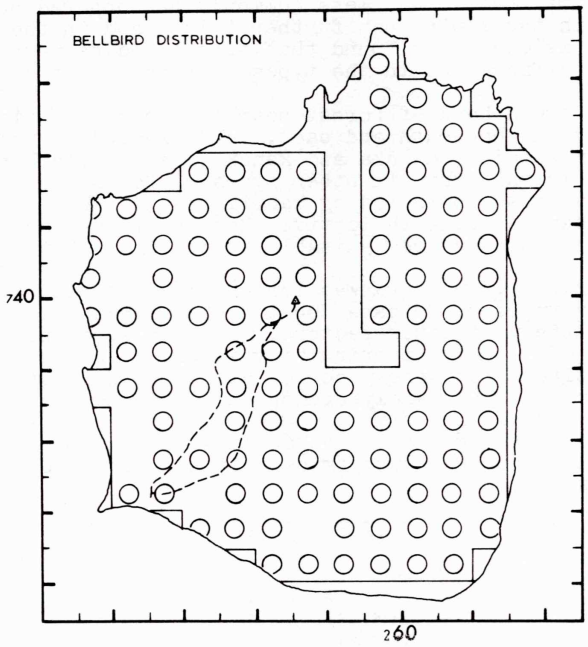


Figure 2. Bellbird distribution on Little Barrier Island.

The rationale behind determining distribution patterns is that species with restricted or irregular distributions are more likely to be adversely affected by change (such as forest exploitation) than the widespread ones. Complete but localised destruction of a habitat, such as clear-felling of a forest, could completely destroy an isolated population of a species with a restricted distribution. A less dramatic change could be equally detrimental. Selective felling of, say, premium grade timber trees, would be more likely to tip the balance against a species with rigid habitat requirements than one tolerant of a wide range of conditions; and although there are other causes, one of the most common reasons for irregular distribution is limitations imposed by habitat requirements. The more fastidious the bird the more restricted its distribution is likely to be.

Using this reasoning, the stitchbird, which was found at only 50 of the 130 stations on the island (38%), is considered likely to have more stringent habitat requirements than, for example, the closely-related bellbird which occurred at 119 stations - 91% of the total.

Having once determined distribution, the survey method allows a bird's occurrence to be matched against a series of different features of the habitat (forest composition , height and density of canopy, landform, aspect and so on) to find out whether irregularities in its distribution can be attributed to any of these things. The distribution map for the stitchbird, for

example, shows that it was less commonly encountered near the coasts and in the south than further inland and in the northern half of the island. We found that this could be partially ascribed to differences in the types of forest in these areas.

A broad band of forest near the coasts of Little Barrier, particularly in the south and east, is dominated by the leptospermum species, manuka and kanuka; and stitchbirds were far less common in this than in other types of forest on the island, particularly those dominated by kauri, rata, tawhero and tawa. This was taken as being indicative that the manuka-and kanuka-dominated forest is a less suitable stitchbird habitat.

However, the bird was irregularly distributed even in the favoured types of forests, so its occurrence there was matched against a variety of other factors. Of these, slope of the ground emerged as being particularly important. Nearly twice the number of stitchbirds were recorded at stations on very steep slopes, which are remarkably common on Little Barrier, than at those on gently-sloping sites. But even the steep slopes could be divided into two groups; the density of stitchbirds on steep slopes facing north was just twice that on steep slopes with a southerly aspect.

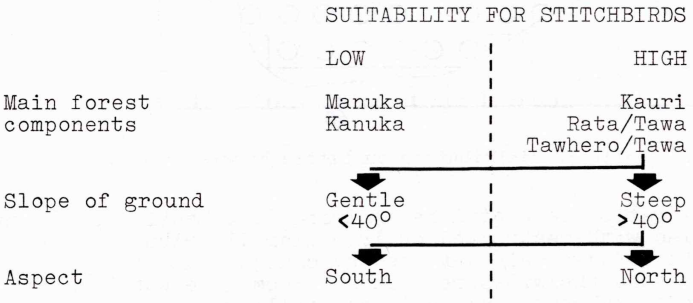


Figure 3. Schematic representation of factors contributing to a stitchbird habitat.

From this we could conclude that the best place on Little Barrier Island to find stitchbirds at the time of the survey was on steep, north-facing slopes in forests other than those where manuka and kanuka are the dominant species (Figure 3); but the survey method allows us to go further. Bird distribution can be matched against factors much finer than ones like forest type or slope or aspect. For example, we found a close association between the distribution of the few stitchbirds that were found in manuka and kanuka forests and the occurrence of a single understorey plant - the shrub Alseuosmia macrophylla. Strangely enough this relationship did not hold in the other forest types, where the shrub was decidedly more common.

The possibility comes to mind that there might have been a direct link between the distribution of this bird and this shrub at the time of the survey. In the types of forest where the shrub was abundant so was the bird and vice versa, and in those forests where shrub and bird were both less common and more irregular in their distribution they were usually found together.

A study of the feeding habits of stichbirds on Little Barrier, by David Gravatt, then a postgraduate student at Auckland University, showed the flowers of Alseuosmia to be an important source of nectar for the stitchbird in October, the month of our survey. So our findings are a first indication that the stitchbird's distribution could be restricted by the occurrence or abundance of a plant it relied on for food. Where the plant is relatively uncommon the few stitchbirds that do occur are found only in its vicinity. Where the plant is abundant so is the bird and the relationship between their occurrence on a small scale is less apparent.

This is far from conclusive, but it provides a line worthy of further enquiry, and this was possible because of the wide variety of information collected during the surveys. Casting back again to David Gravatt's observations; he found that the stitchbird takes nectar from several understorey shrubs other than Alseuosmia; he came to the conclusion that understorey plants were a particularly important source of nectar for the bird. This led us to ask the question: Is there any link between the abundance of shrubs in the lower tiers of the forest and the areas favoured by stitchbirds?

The information needed to answer it was collected in two ways during the survey - as estimates of the density of the upper understorey at each station (of plants over two metres tall which were not part of the forest canopy) and of the abundance of shrubs in the lower understorey (less than two metres tall) at each station. Analysis showed that the understorey was denser and shrubs more abundant in areas already found to be favoured by stitchbirds.

Delving a little deeper into this, to find out something about the reasons behind the difference, we discovered that the canopy of the forest is more even and denser on easy terrain than it is on some steeper areas. However, there is a vast difference between the density of the canopy on steep slopes depending on whether they face north or south. The canopy is very much denser and less broken on southern slopes than it is on equally steep north-facing ones. Consequently more light can penetrate the forest canopy and encourage understorey growth on slopes that are both steep and face north. In addition to this, more light is available on the slopes facing north. This is where the understorey is most prolific (and stitchbirds most abundant).

This should not be regarded as an exhaustive study of the habitat requirements of the stitchbird. Needs other than food could easily contribute to apparent preferences for certain areas and types of forests. Manuka and kanuka forests, for example, are made up of dense thickets of tall, thin stems, while other forests that occur on the island consist of thick-boled trees. As the stitchbird nests in holes, manuka and kanuka forests are likely to be less suitable than the others because they would possess fewer potential nest sites.

However, an exhaustive study of habitat requirements is not the purpose of these surveys. They are the first look at an area and provide pictures of distribution and estimates of abundance of each bird species and estimates of the richness or diversity of the bird fauna as a whole. They also provide some information on habitat requirements from observations made "without hypothesis". That is to say, we do not assemble all the information we have on a species before such a survey, predict that its distribution is dictated by certain specific factors and then go out and collect data to confirm or contradict this particular theory. Such is the approach necessary for any exhaustive study, but ours is much broader. The information collected may need to be applied to several different species and our knowledge of the particular requirements of New Zealand birds is sometimes not very extensive. Consequently we aim to make as precise and complete a description of the habitat at each station as time for data collection allows. And the results of the analysis for the stitchbird show that this approach promises some success. At the very least it provides knowledge on which to base the hypotheses which are a prerequisite to the more incisive, predictive kind of research.

2. Kapiti Island

Like Little Barrier, Kapiti has been a reserve for many years, but there is little resemblance between the two. Most of the vegetation of Kapiti is in various stages of recovery from grazing and burning and the regenerating forests are browsed by a large population of possums.

The Kapiti Survey, done immediately after the one on Little Barrier, was an opportunity to compare the bird fauna and numbers on these widely different habitats. The comparison has a bearing on two questions now receiving a great deal of attention from those interested in birds and forests, namely:

1. Do forests modified by cutting or burning support less species or a smaller number of birds than unmodified forests?

2. Do possums affect bird populations in any way? Do they compete with birds for food or alter the habitat in some other way so that bird populations are reduced?

The comparison was based on bird counts made during exactly five minutes at each station. Every bird seen or heard is noted and the counts give estimates of the number of birds and bird species in the vicinity of each station. Averages between assemblages of stations can then be struck so that various comparisons can be made between two or more habitats; and in this instance Kapiti and Little Barrier were the two habitats compared.

Of the individual birds both the tui and bellbird tend to be more common on Little Barrier than Kapiti. The grey warbler and pied tit are considerably more common on Little Barrier, but for the robin the reverse is true, and the kaka, parakeets and the whitehead occur in about the same numbers on both islands.

The average numbers of birds of all species tended to be lower on Kapiti than Little Barrier and a higher proportion of the ones found on Kapiti were introduced species (chaffinch, blackbird, thrush and so on). Consequently, the overall concentration of native birds on Kapiti was considerably lower than it was on Little Barrier, suggesting that the less modified of the two habitats may be the richer one for birds.

One of the failures of the general survey method is that it takes very little practical account of nocturnal species such as the kiwis. Efforts can be made to search for feathers and other sign while moving between stations, but these are not always effective. Kapiti, for example, has two species of kiwi - the North Island subspecies of the brown kiwi, and the little spotted kiwi - but sign was not reported during the daylight surveys.

However, at night many kiwis could be heard calling and the calls of the two species (and of the sexes of each) can easily be told apart. They also carry for long distances so that parties stationed in each of the main valleys for parts of several nights were able to record the direction each call came from and estimate the distance of each calling bird. In this way a picture of the distribution of each species was built up. The little spotted kiwi was found all over the island but the North Island brown kiwi was far less common and more restricted in distribution.

3. The West Coast Beech Forests

The forests of the beech project area on the west coast of the South Island range from sea-level to the mountain tree line and are found on flat river terraces to steep hill country. Soils and climate vary with altitude and land form and other things such as distance from the coastline, and together they influence the structure and composition of the forests. Although the main tree is usually beech, in some areas podocarps such as rimu occur and different species of beech predominate on different types of country. The result is a mosaic of widely-varying forest types and the main object of the initial series of surveys was to find out the degree of variation in diversity and density of birdlife we are likely to encounter in the region.

This turned out to be considerable. The forest richest in birds had nearly three times the density and twice the species diversity of the poorest; and, generally, the lowland forests had more birds than the higher altitude ones; and the more diverse beech/podocarp forests were richer than the pure beech types. However, there were exceptions to these general trends. Low altitude beech/podocarp forests close to the coast were generally poorer in species and numbers of birds than similar forests, and even some pure beech forests, in the mid-altitude range; and one area of high altitude forest on the eastern side of the Victoria Range was as rich in birds as some of the coastal ones.

In addition, the density of birds in the best of the West Coast forests equalled that recorded on Little Barrier Island and exceeded that for Kapiti. However, we also found that these figures tend to over-simplify the picture. The West Coast forest with the highest density of birds had the greatest concentration of bellbirds, brown creepers, fantails, pigeons and silvereyes. Except for the brown creeper these species were found to be common in all the forests examined. The less widely-distributed species

were most abundant in other areas. Beech/podocarp forest in the hilly country of mid-altitude range behind Reefton supported the highest concentrations of kakas, and milled-over river terraces backed by steeper, hill-country forests at Fletcher Creek had the highest density of parakeets. The fastidious South Island robin - and the tomtit - were most common in the red and silver beech forests on the lower slopes of the Victoria Range and even the apparently poor bird habitats of the coastal belt supported relatively high numbers of robins, tuis, parakeets and riflemen.

These results have shown that proposals for biological reserves for birdlife are going to involve a considerable amount of compromise. Each of the blocks of forest looked at has shown itself to be a distinct type of habitat particularly suitable for one or more of the less common species or capable of supporting particularly large numbers of the ubiquitous ones. Whatever way we look at it I find it difficult to escape the conclusion that the exploitation of South Island beech and beech/podocarp forests must inevitably involve destruction of valuable examples of particular bird habitats.

TAKAHE

J. A. Mills

scientist

The takahe, a large flightless gallinule endemic to New Zealand, is presently one of the rarest birds in the world. In pre-European times the species was distributed through the North and South Islands but is now restricted to approximately 600 square kilometres of Fiordland National Park comprising the Murchison Mountains and an adjacent area between George and Caswell Sounds and the North-West and South-West Arms of the Middle Fiord of Lake Te Anau.

Within the 530 square kilometre Murchison Mountains populations are being studied in three separate areas; Miller Peak, Eyles-Wisely and Takahe Valley-Point Burn. These study areas comprise a total area of 25 square kilometres and include approximately 28% of the tussock grassland and fellfield of the Murchison Mountains. They were chosen because of differences in climate and habitat. The Eyles-Wisely and Miller Peak areas, for example, being closer to the main divide, have almost twice the rainfall of Takahe Valley.

The purposes of the study are to obtain knowledge of the recruitment from reproduction and immigration and losses from mortality and emigration. Such an investigation became necessary because of a recent decline in numbers of takahe in the Takahe Valley area in recent years and the need to assess the overall situation. The Takahe Valley-Point Burn population has been monitored by the Wildlife Service since 1949.

The study has now been in progress for two breeding seasons. Preliminary results show that there are marked differences in the adult and chick survival between study areas. In the Takahe Valley-Point Burn area where the population decline has occurred 27% of the adults have been lost compared with a 13% disappearance for Eyles-Wisely and 12% for Miller Peak (Table 1).

Table 1. Estimates of mortality based on marked takahe in various study areas.

Study Area	No. marked Jan-Feb 73	No. seen following year	Per cent disappeared
Takahe Valley	15	11	27%
Eyles-Wisely	24	21	13%
Miller Peak	17	15	12%
Total	56	47	16%

The hatching success in all study areas, averaging 76% , is approximately the same; however chick survival to at least two months of age amounts to only 25% of those hatching in Takahe Valley-Point Burn compared to over 40% in Eyles-Wisely and Miller Peak areas.

A pair of takahe in typical tussock grassland habitat.
Photo: J.A. Mills.

Overall, there is a high initial chick mortality after hatching, but this tends to level off after three months (Figure 1). In 1972-73 by 31 March only 19% of the chicks were still alive, but of those that survived to then 54% were known to be alive at one year of age. In 1973-74 by the 31 March there was a 43% survival of chicks. The reasons for the marked differences in the chick survival between the two seasons may be related to the earlier breeding that took place in the 1973-74 season. The winter of 1973 was extremely mild and birds tended to lay approximately a month earlier than the previous year.

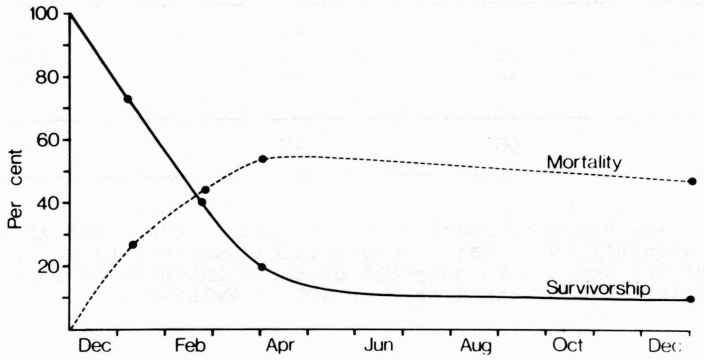


Figure 1. Survivorship and mortality of chicks from the 1972-73 season. The mortality curve represents the % of mortality between sampling periods.

Overall for the 1972-73 season there were at least six chicks produced to one year of age in the Eyles-Wisely and Miller Peak areas and a loss of five adults. The production therefore was slightly higher than the losses of adults. In addition there was a nett gain of three pairs from immigration in both the Eyles-Wisely and Miller Peak areas.

In comparison, in Takahe Valley-Point Burn there was only one chick produced to one year of age and a loss of five adults. There was a gain of one pair through immigration, so overall there was a nett loss of two birds from the population.

Studies are continuing to establish why the Takahe Valley-Point Burn population is not doing very well. The mean weights of adults in this area are significantly less than the birds in the other two study areas and so it would seem that the area is suboptimal.

Although Takahe Valley-Point Burn has maintained a high population in recent years, it would appear that this could have been due to immigration rather than habitat suitability. Thus, in times of high production of chicks in more favourable areas, the surplus of birds which cannot find suitable sites in the favourable areas is forced to settle, if only temporarily, in

places such as Takahe Valley. If this hypothesis is correct then there has been a decline in production in the more suitable areas as well.

Beech forest interior of Takahe Valley showing an absence of a palatable herb and fern understorey attributable to deer browsing. Photo: R. Lavers.

There are two factors which probably make Takahe Valley-Point Burn less attractive than the other study areas. Firstly, the low alpine areas below bushline in Takahe Valley consist mainly of red tussock (Chionochloa rubra). This tussock is less nutritious than the broadleaved tussock (Chionochloa flavescens) and midribbed tussock (Chionochloa pallens) of the Eyles-Wisely and Miller Peak study areas. Secondly, in Takahe Valley the essentially pure mountain beech forest is virtually devoid of small-tree, scrub and herbaceous layers, except for the regenerating beech which appears to be adequate for replacement purposes. By contrast, the predominantly silver beech forests of the western study areas (Miller Peak and Eyles-Wisely) have relatively well developed sub-canopy layers and a much richer flora. Dr Alan Mark of the Department of Botany, Otago University, who did a botanical survey of the Muchison Mountains, considers that these differences could be due in part to differences in climate, but that differences either in density or impact of deer, or of rates of recovery following their reduction are likely to be more important. In winter, when snow covers the tussock grasslands, the birds retreat into the bush to feed on herbs and fern. In Takahe Valley-Point Burn the poor state of the bush understorey may be a limiting factor to the takahe population, especially if in some years snow persists for a lengthy period and prevents feeding on tussocks. Intensive botanical studies on winter food supply are required to establish any definite conclusions.

MT. BRUCE NATIVE BIRD RESERVE

C.D. Roderick
officer in charge

Some ten hectares are under development at the Reserve and aviaries now comprise two standard breeding blocks of 125 and 160 square metres; two natural bush enclosures, of 310 and 270 square metres; and two curved enclosures for waterfowl of 700 and 360 square metres over a spring-fed stream. The area totally enclosed by netting is 1,925 square metres.

Open units comprise a 1 hectare bush enclosure with nine subdivisions - two dividing the major part of the area for takahe and seven of over 90 square metres for kiwi; a 0.6 hectare duck pond; and an enclosure of 350 square metres.

Servicing facilities now comprise a 180 square metre building incorporating workshop, food room, incubator room and a brooder room; and staff quarters with three single rooms and a four-berth bunkroom.

Because of the protracted and complicated takahe breeding programme, the Reserve was closed to the general public for most of 1973 but school and other groups were provided for by arrangement. Although not widely advertised, an open period from Easter to the end of the May school holidays was well attended and enthusiastically received. Exhibits, films and guided tours were arranged and staff were able to show and explain all aspects of their work to visitors. Previously, during the more extended open periods, visitors had limited contact with staff who had little time to spare from their normal duties.

More importantly, however, the restrictions on public visiting reduced disturbance and resulted in an extended and more successful breeding season. We now have the possibility of takahe nesting from September through until perhaps February, with possibly six nestings and production of up to 12 eggs per pair, whereas breeding usually ceased when the Reserve was opened for the Christmas school holidays.

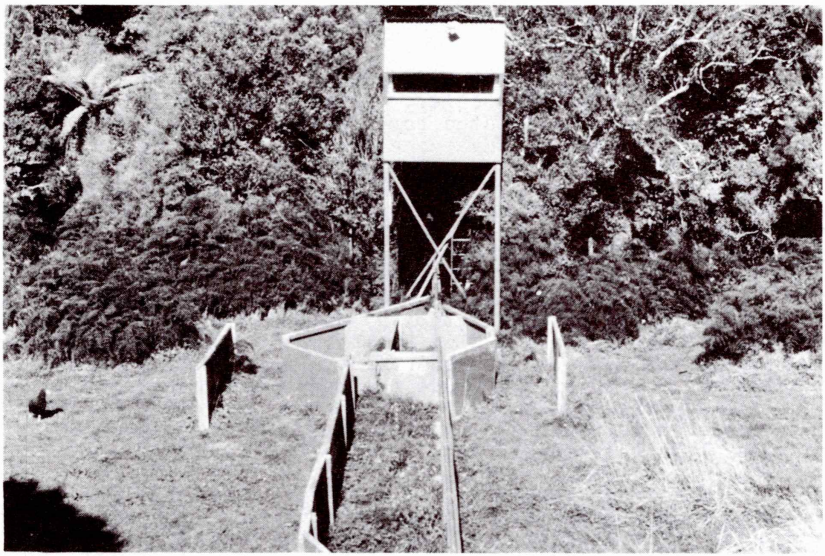
Aviculture

First priority was naturally accorded the takahe. The territory boundary and neutral zone arrangements were upgraded and a new tower hide installed which permits hitherto unwitnessed behaviour in the neutral zone and improved observation over both pens. New recording equipment was purchased and variable flood-lighting installed over the enclosures. The next priorities were mass production of brown teal for continued liberations in suitable areas, and the breeding of blue duck. Space for these latter two

projects became available on completion of the mallard/grey duck hybridisation experiment for which some 700 specimens were produced since 1967.

At the start of the breeding season 26 species were being held, seven of one sex or as single birds. A North Island brown kiwi female died before breeding commenced, and this was particularly unfortunate as it meant the loss of the first uninjured adult pair of this species held at Mt Bruce. Thus the breeding season commenced with 18 species with the potential to breed and all these produced fertile eggs.

Sixteen species hatched young but four failed to rear young. Three species bred for the first time at the Reserve but two of these failed to rear young. Single females of the large grey kiwi and the South Island brown kiwi, species not held at the Reserve before, were received.



The neutral zone arrangement and tower hide in the takahe enclosure. Photo: C.D. Roderick.

Takahe

Subsequent to the very detailed post-mortems on the two chicks hatched last season, which showed physical abnormalities strongly suggestive of being congenital defects, the breeding pair was split while still foster-rearing a pukeko chick. The male, "Pooh", was replaced by "Jock" - a massive, dominant bird well adjusted to captivity.

A proven breeding pair was taken from the wild in early April and released into the breeding enclosure in early June. Unfortunately the female severely damaged the tendons of one leg several days later and these failed to mend in time for the full sequence of pre-breeding season stimulation procedures to be implemented. In late July both birds were removed to a small holding pen and replaced by Pooh and "Prudence" who were to have acted as the trigger pair to stimulate the breeding pair, Jock and "Gretchen".

All the birds appeared to be in fine condition and the programme proceeded with promising results only to be disrupted in early August when the male, Pooh, died of what appeared to be a coronary failure. The remaining spare male, "Modok", was quickly introduced to Prudence and stimulation sequences recommenced in mid-August. These again developed satisfactorily until early September when they were totally negated by the death of Modok. Meanwhile, protracted and intensive investigations into the first death had revealed a haemolytic condition and this, plus an infection of meningitis, became evident during investigation of the second death.

As a result of the post-mortem investigations, all birds were confined to treatment cages, tested for haemolysis and, as a precautionary measure, treated for meningitis. All except the new pair had haemolysis of varying degrees of severity from which they recovered after lengthy antibiotic treatment and therapy. An adverse drug reaction when treating for possible meningitis transmission resulted in partial paralysis of the new male's leg which prevented him from copulating with his mate whose previously damaged leg had fully mended.

Investigations into the deaths were done by Dr J.E. Lohr, Senior Lecturer in Poultry Pathology and Medicine, Department of Veterinary Pathology and Public Health, Massey University, to whom, and also to the Head of the Department, Professor B.W. Manktelow, we owe a great debt of gratitude for undertaking what turned out to be a major investigation. We are also grateful to the many other researchers, specialists, veterinarians and "lay workers" who were ultimately involved.

All birds were held in small temporary pens for the duration of the normal breeding period from mid-September to early December; efforts being initially directed to preventing further losses and to treating debilitated birds. Despite these conditions both pairs produced single two-egg clutches which, however, were infertile.

The "breeding pair", Jock and Gretchen, had recovered sufficiently to be released into the breeding enclosure in early December (when, in previous years, laying had normally ceased) and a further clutch of one egg was laid despite the female not being in perfect condition. As the nest was sub-standard and incubation behaviour atypical, the egg was transferred to a bantam. That the embryo developed abnormally and died at ten days, was probably a reflection on the female's condition.

Thus, for the second successive year, fertile eggs have been produced in captivity; an indication that management is proceeding along the right lines.

The haemolytic condition, hitherto undetected or described, has been provisionally termed "intravascular haemolysis". Its cause is as yet unknown but it is apparently endemic in some wild pukeko populations in the Wairarapa and Manawatu. It has also been identified in waterfowl, and blue duck at the Reserve are affected. It is possible that it also occurs in the wild takahe population as well. Investigations are still proceeding in conjunction with Massey University.

Brown Teal

A small liberation of 17 pinioned birds from last season's surplus stock was made in July at Lake Omanuka in the Manawatu. Recent sightings and trapping indicate a number still surviving and in very good condition although breeding has not been confirmed.

Nine pairs were held for the breeding season, three on the waterfowl pond and six in separate pens in a waterfowl aviary. Eight pairs produced eggs, with laying beginning in August and continuing with some pairs into February. Egg production and hatching success by individual pairs varied with age, pen conditions and order of dominance, ranging from a single clutch of five eggs to seven consecutive clutches and 40 eggs. By mid-February the eight pairs had produced 31 clutches and 167 eggs - 69 infertile and 98 fertile: 36 embryos died in the shell and 59 hatched.

Blue Duck

This species first bred at Mt Bruce in 1964 when a single clutch of five fertile eggs was produced by a pair on the then sparsely populated waterfowl pond. Two young hatched and were reared successfully. Despite having a male and female each season since, no breeding occurred until last year, although courtship behaviour was observed. Failure to breed was attributed to disturbance by an increased population of other waterfowl, as blue duck are a solitary species. In October 1968 an unattached female laid a single clutch of four eggs which were all infertile.

Insufficient time and lack of suitable accommodation hampered serious attempts to breed the species until last season when a free flight pair was held in an enclosed waterfowl aviary and a pinioned pair was held in an isolated enclosure free from other ducks. Both pairs bred, producing single clutches of four and five fertile eggs respectively. Potential rat predation dictated immediate removal of the five-egg clutch to bantams, but embryos died at 17,21,31 and 33 days with one chick hatching and dying in the nest after 34 days incubation. The free flight pair, being in a secure area, was left to incubate naturally but, after 22 days, the duck deserted when an egg exploded under her. Three eggs were salvaged and the two with live embryos hatched after a total incubation time of 34 days. The chicks, both males, were reared to maturity.

This season the same pairs were held under the same conditions and both laid. The free flight pair laid three clutches. The first consisted of six fertile eggs which were collected as laid and incubated by a bantam. Again embryos died, two at 8 days, one at 12 days, one at 30 days and two, one of

which pipped, at 34 days. The second clutch of six eggs was treated similarly but embryos died at 7,12,23 and 26 days. Two chicks hatched after 34 and 35 days but one died in the nest and the other a day later. The third clutch, of five eggs, was left to be incubated naturally. One embryo died before 28 days, one died at hatching, and three chicks hatched and were reared.

The pinioned pair also produced three clutches and the first, of six eggs, was collected and incubated by a bantam. All eggs were fertile but one embryo died at 18 days, three died at 34 days, and two chicks hatched and were reared. The second clutch, of five eggs, was incubated by the parents for about four days, after which time conditions dictated removal. Three eggs were infertile, one embryo died and one chick hatched with assistance and was reared. At this stage testing for haemolysis was being done and the male proved to be a confirmed case. The third clutch comprised four eggs, one soft-shelled and laid in the pond, and one infertile; two fertile eggs, one of which was cracked but successfully sealed, hatched in an incubator and the chicks were reared.

As a routine procedure all eggs are measured, weighed fresh and as incubation proceeds, so as to monitor moisture loss, both under artifical and natural conditions. Comparisons revealed that artifical incubation of blue duck eggs requires a drier environment than for the eggs of other ducks. This is to compensate for the longer (34-35 day) incubation period. Eggs in which embryos died at a late stage seldom lost more than 10% moisture, whereas eggs successfully hatched, either naturally or artifically, lost about 14%. Although a 14% level of moisture loss is normally aimed for, we are unable to attain this with any degree of accuracy or consistency; some eggs in the same clutch under the same bantam losing only 9%, and others losing up to 19%. Observations of incubating blue ducks suggest an unusual incubation pattern - the eggs being well covered with debris while the duck is sitting. Further observation is required to monitor this behaviour more accurately. The incidence, rare in ducks, of various degrees of faulty positioning of the embryo also suggests that the blue duck has an unusual incubation pattern.

Extensive use of the incubator was not practical at the time as extensive and irregular power cuts were being experienced.

Other Waterfowl

Paradise duck, grey duck, grey teal and New Zealand scaup bred successfully. Shoveler, however, failed to rear any young and this is thought to be due to a gross sex imbalance which disrupted pair formation. After some six to seven years of a male scaup consorting with a female grey teal, apparent hybrid offspring have been produced - this being an inter-generic cross of some interest.

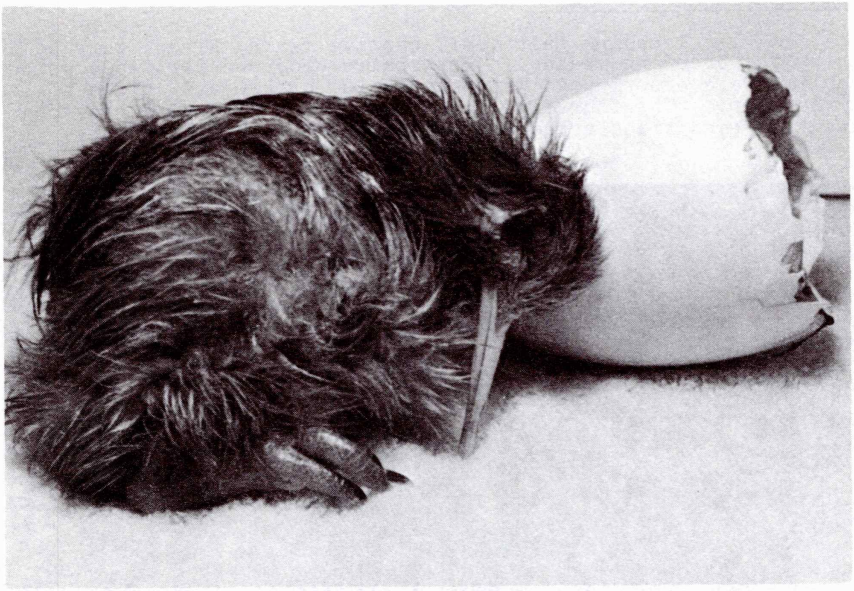
Little Spotted Kiwi

The chick of this species which was bred last season has reached the weight of an adult male. The breeding pair again laid: one egg on 29 July and another thought to have been laid on 17 August. Although a bird was sitting on the 10th, 14th and 26th day after the first egg was laid, full time incubation did not start until the 27th day. After 60 days full-time incubation

renovations were made to the nest, probably as the result of an egg exploding. The remaining egg hatched after 84 days. The chick, which was taken from the nest eight days after hatching, weighed 157 g. Despite the same techniques being employed, however, it failed to progress as well as the chick reared the previous year. At 49 days it swallowed about a dozen small stones weighing nearly 12 g, and its condition slowly deteriorated until death at 79 days.

North Island Brown Kiwi

Although no mature pairs were held during the breeding season, a chick was successfully hatched and reared from an egg unearthed in land development operations. The egg was thought to have been incubated for about 53 days, leaving 19 days to hatching for a 72-day incubation period. And this proved to be the case. Incubation was by a bantam until hatching started, after which the egg was placed in a thermostatically controlled cupboard. This is one of the few times that the hatching of a kiwi egg has been observed, and the process was fully documented and photographed. Another egg, thought to have been incubated for ten days, was received, but the embryo died at 18 days. This was probably the result of the egg being turned, as we now have some evidence that kiwi eggs may not be turned in the normal manner.



North Island brown kiwi chick just after hatching.
Photo: C.D. Roderick.

North Island Saddleback

For the first time at Mt Bruce, this species failed to hatch young. The only breeding female, aged at least 9 years, died after laying and the young of last season were not mature.

Eastern Weka

Experimental hand-rearing only was undertaken this year to condition young to a "social situation". This is a preliminary to future work aimed at reducing or eliminating territorial breeding behaviour and encouraging social/communal nesting appropriate to captive conditions where space is limited. Eggs were part incubated by the parents and then completed by bantams.

Red-Crowned Parakeet

Preoccupation with takahe and other priorities precluded the planned "mass production". Communal nesting colonies were tried but with limited success. Despite this, over 70 birds were available for restocking Cuvier Island and for establishment on Tiritiri Island in the Hauraki Gulf. Selected pairs were used to foster-rear, and increase productivity of, the limited breeding stock of the Antipodes Island parakeet.

Antipodes Island Parakeet

Two breeding pairs, all captive reared birds, were held during the breeding season. Both pairs produced fertile eggs but problems were experienced with eggs being broken and chicks killed in the nest. The four fledglings that were eventually produced were from eggs transferred to nests of red-crowned parakeets.

Antipodes Island parakeet. Photo: B.D. Bell.

Reischek's Parakeet

Two breeding pairs produced 10 eggs, six of which were infertile. Two embryos died in the shell and two chicks hatched and were reared.

Tui

To gain further experience with nectar feeders, two tui broods, each of four young, were collected locally for hand rearing. Two adults, both of which had been injured, were held at the same time and an abandoned nestling was hand reared.

The first four nestlings were collected when they were about 12 days old, and were reared on a fluid mix of honey, finely ground cereals plus milk derivatives supplemented with meal worms and poultry pellets. All died before reaching maturity. Bacterial infection was suspected as the cause of two of the deaths. This emphasizes the need for strict hygiene when feeding an ideal culture media, i.e., sugar and milk compounds, to brush-tongues. Two deaths were attributed to heat prostration.

The second brood was collected when the nestlings were about 10 days old. Half of this brood was reared to maturity.

In June, the four young then held were paired but a male died in August. Preliminary nest building occurred but no nests were completed. The remaining male and one female were transferred to another aviary in October and a nest was built and two eggs of a three-egg clutch were laid within a fortnight. The nest was left undisturbed until one egg was found broken beneath it. The two remaining eggs were then candled, found infertile and removed.

A second nest, sub-standard compared with the first one, was "completed", and laying began eight days after the removal of the eggs from the first nest which had been incubated for the full term. Four eggs were eventually produced, two were fertile and two infertile. The fate of one fertile egg is not known but the other one hatched and the chick fledged 21 days after hatching.

Coinciding with the late nestling stage and fledging, a third and typical nest was built. Laying apparently commenced about 14 days after the chick from the second nest was hatched and four eggs were produced. One chick was successfully reared and fledged 20 days after hatching.

As parental attitude in the presence of a second hatching was uncertain, the first fledgling was transferred to another aviary where there were three newly-fledged hand-reared young. However, severe stress was evident in this bird and it was returned to its parents who accepted it with alacrity, the male continuing to feed it while the female brooded. Both parents feed the young but, during their early development, the female has the dominant role while the male, who guards the territory, feeds them only occasionally and in the late nestling stage. After they have fledged, the female appears to take little part in feeding the young.

It is interesting that no aggression has been shown by

the parents towards the first-hatched young despite subsequent renesting and hatching.

Morepork

Two newly fledged nestlings were received from the Hawkes Bay Acclimatisation Society on 1 January 1972. They accepted food readily from the hand:- moths, nestling and young white mice, meal worms and the meat fed to kiwis.

In December 1972 attempts at nest building in a nest box containing rotten wood were observed. As the birds appeared to be disturbed by human activity and by a wild morepork which frequented the unit, they were removed to a less disturbed, more shaded, and totally roofed aviary.

The first egg was laid on 21 September 1973 and the second laid in another nest box two days later. The first egg was put with the second the following day at a time when the female was off the nest. Incubation commenced with the first egg. On 6 October, three eggs were present and candling showed two to be fertile. A disparity in development was already apparent.

The first egg pipped on 25 October. On 27 October, the female never left and the male was observed taking moths to the nest. On 28 October the chicks were found injured in the other nest box and they later died. One weighed 16.8 g and the other 13.7 g. On the night of 27-28 October the male was seen to go into the nest with food and may have been responsible for the injuries. Several factors were operative at the time : (1) disturbance by ourselves, (2) disturbance by a wild bird outside the aviary, (3) the food supplied included small white mice and this may have obscured the identity of the chicks.

Renesting occurred on the 15th November, 19 days after the loss of the chicks, but the single egg was infertile.

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RECENT SCIENTIFIC PUBLICATIONS

154 Hellyer, N.R., F.C. Kinsky, and M.J. Imber 1973.
A soft-plumaged petrel from the Bay of Plenty.
Notornis 20 (1): 71-72.

155 Imber, M.J. 1973.
The food of grey-faced petrels (Pterodroma macroptera gouldi (Hutton)), with special reference to diurnal vertical migration of their prey.
Journal of Animal Ecology. 42 (3): 645-662.

156 Mills, J.A. 1973.
Some observations on the effects of field applications of fensulfothion and parathion on bird and mammal populations. Proceedings of the N.Z. Ecological Soc. 20: 65-71.

157 Caithness, T.A., and W.J. Pengelly 1973.
Use of Pukepuke Lagoon by waterfowl. Proceedings of the N.Z. Ecological Soc. 20: 1-6.

158 Crook, Ian G. 1973.
The tuatara, Sphenodon punctatus Gray, on islands with and without populations of the Polynesian rat, Rattus exulans (Peale). Proceedings of the N.Z. Ecological Soc. 20: 115-120.

159 Lavers, R.B. 1973.
Aspects of the biology of the ferret, Mustela putorius forma furo L. at Pukepuke Lagoon.
Proceedings of the N.Z. Ecological Soc. 20: 7-12.

160 Williams, Murray 1973.
Mortality of the black swan in New Zealand.
Wildfowl. 24: 54-55.

161 Robertson, C.J.R. 1974.
Preliminary report on bird banding in New Zealand 1972-73. Notornis 21(1): 70-78.

162 Williams, G.R. 1973.
Birds. The Natural History of New Zealand. 304-333.

163 Atkinson, I.A.E., and B.D. Bell 1973.
Offshore and outlying islands. The Natural History of New Zealand. 372-392.

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